DESIGNING WASTE WATER TREATMENT UNIT FOR METHANOL PLANT

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CHEMICAL ENGINEERING
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by

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Dissertation submitted in partial fulfilment of
the requirements for the
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(Chemical Engineering)

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CERTIFICATION OF APPROVAL

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

NUR SHAFINAZ BT SHAFEE

ABSTRACT

Water Treatment System is specially designed to treat the water or effluent before being discharged into the sea water, river or other water sources. Usually it is installed because the effluent contains lots of chemicals, suspended solids or micro organisms. These will definitely contribute to the water pollution. This should be avoided because the pollution will affect the human health and the main is the environment itself. Different industry will have to use different technologies of water treatment depending on the chemicals or materials used. The water treatment technologies are activated sludge systems, sand filter, aerated lagoon, bead filter, ion exchange and dissolved air flotation. Certain area of study needs to be revised to produce a water treatment unit that is useful in reducing the certain parameters such as BOD (Biological Oxygen Demand), COD (Chemical Oxygen Demand) and Cadmium ion. From the analysis done, BOD is obviously the critical parameter where it should be treated before being discharge. The suitable treatment is the biological wastewater treatment. Activated sludge process is the type of biological wastewater treatment to be used. Using this treatment, BOD can be reduced up to 95 – 98%. However, since there some other heavy metals exceed too, the treatment should be started with pre-treatment first to remove them because heavy metals will cause toxicity during the activated sludge process.

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ABBREVIATION

PM(L)SB : PETRONAS Methanol (Labuan) Sdn Bhd

BOD : Biological Oxygen Demand

COD : Chemical Oxygen Demand

EQA 1974 : Environmental Quality Act 1974

WSP : Waste Stabilization Pond

CMAS : Complete Mixed - Activated Sludge

SBR : Sequencing Batch Reactor

RAS : Return Activated Sludge

TSS : Total Suspended Solids

MGD : Million Gallons Per Day

MGH : Million Gallon per Hour

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

PETRONAS Methanol (Labuan) Sdn Bhd or PM(L)SB is known as methanol producer. There are several units which are the main units and the supporting units in producing methanol. The main unit is the reforming, synthesis and distillation. Meanwhile the supporting units are demineralized water, air separation unit and gas turbine generator. Methane is the main source in this industry. Methane will reform other gases after going under some reactions. These reactions would definitely use up catalyst as a driving force. Catalyst such as Zinc Oxide is metal. The usage of the different kind of catalysts and reactants are the major factor that contributes to the various compositions in the effluent discharge, which is the water that flow into the nearest water source which is the sea. However, the compositions or parameters of the effluent need to comply with the standard limit of Environmental Quality Act 1974 (EQA 1974). Therefore, the effluent should be treated first before discharging to the sea in case the parameters exceed the standard limit.

1.2 PROBLEM STATEMENT

In PETRONAS Methanol (Labuan) Sdn Bhd or PM(L)SB, there is no waste water treatment system that treats the effluent before being discharged into the sea. Therefore, if some of the parameters such as BOD, COD or Cadmium ions exceed the standard limit of EQA 1974, the sea will get polluted. Therefore, the purpose of this work is to design a water treatment unit to treat the effluent discharge before it flows into the sea in order to comply with EQA 1974.

1.3 OBJECTIVES AND SCOPE OF STUDY

1.3.1 Objectives

The objectives of this work are:

- To analyze the effluent discharge from the methanol plant
- To design and propose a water treatment unit for methanol plant based on the result obtained from the analysis

1.3.2 Scope of Study

The scope of study involves are:-

- Analysis of the effluent samples
  - Samples were taken from the company and each sample was analyzed for certain parameters.

- Research study on the types of water treatment unit
  - Types of water treatment unit are important because it will determine the removal efficiency of the exceeding parameters. Therefore, each and every part of water treatment unit need to be analyzed and understand.

- Study on the Environmental Quality Act 1974 (EQA 1974)
  - EQA 1974 highlights the standard limit of discharge of certain parameters. Therefore, EQA 1984 should be the benchmark of the samples.

1.4 FEASIBILTY OF THE PROJECT

This project can be done with the cooperation from the company involved which is PM(L)SB. The design of the water treatment unit is depending on the information that comes from the company itself such as the space available for the water treatment unit, the effluent flow rate and samples taken.

CHAPTER 2

LITERATURE REVIEW

In Malaysia, Department of Environment which is under the Ministry of Natural Resources and Environment is the responsible party for the environment. In order to keep our environment safe from any pollution, they create laws regarding this matter. Our environment can be polluted in various ways. It can be either water pollution, air pollution or land pollution.

In this case, we will focus on the water pollution. Water will get polluted if any wastes that are coming from houses or industries gain access to water sources such as river or sea. It will happen if the wastes are not treated first before being discharged to the water sources. This is the reason for Department of Environmental to create an act called Environmental Quality Act 1974.[1] This act can be further divides into several parts which are the regulations and order.

For this case, PM(L)SB needs to follow the Environmental Quality (Sewage and Industrial Effluents) Regulations 1979. Since PM(L)SB is one of the industries that discharge their effluents to the sea, they need to comply with the Third Schedule of Environmental Quality (Sewage and Industrial Effluents) Regulations 1979. [1] This Schedule provides the parameter limits of effluent for industries to follow. Table 1 shows the details on the parameter limits. PM(L)SB need to comply with the standard B. This is because the effluent is being discharged directly into the sea water and will not be used for portable drinking.

Any of these parameters exceed the standard limit may cause adverse effects to the environment particularly the water surface. For instance, if BOD exceeds the standard limit, it would affect the river or sea water. BOD is referring to the oxygen level in the water. High BOD tells us that there is less dissolved oxygen to be used up by aquatic life. This would lead to the death of aquatic life such as fishes and the aquatic plant. Meanwhile high in metals such as Copper, Zinc, Iron, Chromium and Tin may have toxicity effects to the biological community. This can affect the human and aquatic life.

Table 1: Parameter limits of effluent of standards A and B [1]

Parameter	Unit	Standard	
		A	B
Temperature	°C	40	40
pH Value	-	6.0-9.0	5.5-9.0
BOD at 20°C	mg/l	20	50
COD	mg/l	50	100
Suspended Solids	mg/l	50	100
Mercury	mg/l	0.005	0.05
Cadmium	mg/l	0.01	0.02
Chromium, Hexavalent	mg/l	0.05	0.05
Arsenic	mg/l	0.05	0.10
Cyanide	mg/l	0.05	0.10
Lead	mg/l	0.10	0.5
Chromium, Trivalent	mg/l	0.20	1.0
Copper	mg/l	0.20	1.0
Manganese	mg/l	0.20	1.0
Nickel	mg/l	0.20	1.0
Tin	mg/l	0.20	1.0
Zinc	mg/l	2.0	2.0
Boron	mg/l	1.0	4.0
Iron (Fe)	mg/l	1.0	5.0
Phenol	mg/l	0.001	1.0
Free Chlorine	mg/l	1.0	2.0
Sulphide	mg/l	0.50	0.50
Oil and Grease	mg/l	Not detectable	10.0

* Standard A: Into any inland waters within the catchment areas specified in the Fourth Schedule
* Standard B : Into any other inland waters

Therefore, as a method of prevention, industries should equip their plant with water treatment unit. Lots of study has been done on wastewater treatment unit to decrease the water pollution. The wastewater treatment unit is designed based on the focusing parameters.

2.1 EFFECTS OF POLLUTION

There are two types of contaminant effect. The first is toxicity and the second is oxygen depletion. Toxicity is poisoning and it occurs primarily with metals and certain types of organic chemicals. Toxicity can be acute or chronic and tests for effluent quality are increasingly being defined by toxicity testing as well as by contaminant measurements in the effluent.

Effluent Toxicity Testing

The two most common types of toxicity testing are on minnows and water bugs. The tests are either static (fixed volume) or flow-thorough tests, which have duration from 1 hour to as long as 9 days. The tests procedures are designed to determine any residual toxicity in the effluent, which may come from untreated chemicals and metals. Effluent toxicity is of special importance where the effluent limitation parameters in the permit do not require specific testing for the chemical compounds in the plant. The test conditions must measure the survival of the organisms.

Oxygen depletion – Biological Oxygen Demand

The BOD test is based upon the Winkler Dissolved Oxygen Test. In it the concentration of oxygen is measured by titration of a manganous sulphate and alkaline sodium azide solution with dilute sulphuric acid in the presence of starch. The test is most often run for 5 or less frequently for 20 days. The BOD test is time, temperature, nutrient and waste acclimatization sensitive. BOD also is a measure of the rate of biological degradation of the material. It is primarily a measure of the carbonaceous demand.

Biology of Polluted Water

The change in oxygen levels in the stream leads to changes in the aquatic environment. Many of these changes are reversible but some are not. The changes occur not only to the chemistry but also to the biology and ecology of the stream.

As the oxygen levels start to drop, species begin to disappear. Certain species such as trout and game fish require minimum dissolved oxygen content. If the oxygen content falls below the critical level, the fish cannot traverse the region and migration for spawning is effectively eliminated.

The river is essentially dead until carbon is consumed to the point where re-aeration from the surface can begin to supply oxygen to the river or entering streams carrying dissolved oxygen have sufficient dilution to change the anaerobic conditions. At that point, the river can start to recover but the ecology has changed. Below are the biological changes that might be occurring:-

- Loss of aquatic species
- Development of anaerobic deposits further degrades water
- Water turns black
- Chemical reduction of metals oxides
- Development of benthic organisms and sludge worms
- Total depletion of oxygen from nitrates and the from sulfates
- High amine levels
- Extremely slow stream recovery

2.2 WASTE STABILIZATION POND (WSP)

A study has been done on Waste Stabilization Pond (WSP) unit in order to remove BOD. [3] BOD has been reduced to 15.4 ppm from 357 ppm which gives about 95.67 % of removal. This unit comprises of one facultative pond, three maturation ponds and a contact filtration.

In designing the WSP unit, the parameters that should be considered are temperature and wastewater flow rate. The waste water flow rate would affect the area required. Then only, the design of facultative pond and maturation pond take into account. The equation below can be used to calculate the area of the facultative pond.

$$A = \frac{Q}{DK_1}\left[\frac{L_i}{L_e} - 1\right] = \frac{Q}{DK_1}\left[\frac{L_i - L_e}{L_e}\right] \quad \text{..............................[1]}$$

A = Area of the pond

Q = Volumetric Flow Rate

D = Depth of the pond

K = Rate Constant

L_i = BOD of the influent

Detention time also need to be calculated. This would determine the number of the pond required. To calculate the detention time:

$$t = \frac{AD}{Q} \quad \text{...[2]}$$

The other factor is the design of the maturation pond. The area of maturation pond can be calculated by the equation below.

$$A_m = \frac{Qt_m}{D} \quad \text{...[3]}$$

A_m = Area of the maturation pond

Q = Volumetric Flow Rate

T_m = Detention time

D = Depth of maturation pond

After the first stage of treatment, which is the facultative pond, the BOD reduced to 195 mg/L. The facultative pond was able to remove 45.2% of the BOD. [3] The second stage of treatment which comprises three maturation ponds in series reduced the BOD to 32 mg/L. After filtration through the clay media the BOD was reduced to 15.4 mg/L. Table 2 will summarize the amount of BOD removal.

Table 2: Result of BOD analysis using WSP unit [3]

Sample	Observed BOD (ppm)	Calculated BOD (ppm)	Observed percentage removal (%)	Calculated percentage removal (%)
Influent wastewater	356	-	-	-
Facultative pond effluent	195	137	45.2	61.5
Maturation pond effluent	32	18.3	83.6	90.6
Final filtration effluent	15.4	-	95.67	-

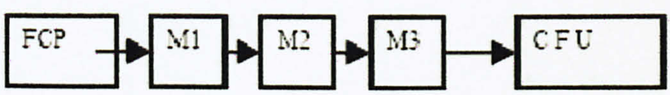

Figure 1: The designed waste stabilization pond in series with the contact filtration unit [3]

Table 3: Prototypes and model dimensions for volumetric flow rate of 122.3 m^3/day [3]

Parameter	Prototype facultative pond	Model pond	Prototype maturation pond	Model pond
Area (m^2)	894.29	0.805	407.67	0.985
Discharge (m^3/s)	1.42×10^{-3}	1.9×10^{-6}	1.42×10^{-3}	1.9×10^{-6}
Detention time (days)	11	4	3	3
Length (m)	51.9	1.5	35	1.2
Breath (m)	17.3	0.7	12	0.78
Depth (m)	1.5	0.7	1.2	0.5

WSP units are now regarded as the method of first choice for treatment of wastewater of wastewater in many parts of the world. In Europe, WSP are widely used for small rural communities. [3] Since WSP focusing on the BOD reduction, it can be referred as a guideline in designing a waste water treatment unit for methanol plant.

CHAPTER 3

METHODOLOGY

3.1 RESEARCH METHODOLOGY

3.1.1 Experimental Work

3.1.1.1 Waste water sampling

Samples will be taken from the company within a range of time to analyze it. Samples will be taken from two points of discharge which are the neutral basin point and effluent discharge point. Neutral basin is the point where the effluent being discharged directly from the basin. Meanwhile, the effluent discharge point is the point that the effluent has flow in the drainage system.

3.1.1.2 Waste water analysis

Analysis will be done on the samples to check for certain parameters. It will cover on the data obtained once the test on the samples has been done. These parameters will then be compared with the Third Schedule in the Environmental Quality Act 1974. [1] Any parameters exceed the standard limit would define as incompliance with the law.

3.1.1.3 Unit involved

The project has involved the plant area site. It comprises of Demineralised Water Unit (Unit 500 and Unit 550) of PETRONAS Methanol (Labuan) Sdn Bhd.

3.1.2 Theoretical Work

3.1.2.1 Factors to be considered in designing waste water treatment unit

a) Wastewater Flow Rate

Wastewater flow rate is the discharge amount of wastewater from PETRONAS Methanol (Labuan) Sdn Bhd to the nearby water sources. This amount would determine the size of water treatment unit for the plant. Size of the treatment unit is important to make sure it has enough capacity to support the load

b) Space / Area of plant site

Design and capacity of water treatment unit depend on the space available at PETRONAS Methanol (Labuan) Sdn Bhd. Design required for the treatment unit and the space or area available at the plant site should be feasible enough to carry the load.

c) Composition of Waste water

Composition of the waste water would determine the problem that is encountered by the company. Analysis of the samples will narrow down the focus. Therefore, main focus will be on the critical composition that exceeds the standard limit.

3.2 PROJECT ACTIVITIES

Table 4: List of the project activities for 14 week

Detail / Week	Week														
	1	2	3	4	5	6	7		8	9	10	11	12	13	14
Project Work Continue	■	■	■												
Submission of Progress Report 1				■	■										
Project Work Continue				■	■	■	■								
Submission of Progress Report 2									■						
Seminar								Semester Break		■	■	■			
Project Work Continue									■	■	■	■			
Poster Exhibition												■	■		
Submission of Dissertation (soft bound)														■	
Oral Presentation															■
Submission of Project Dissertation (hardbound)															■

3.3 KEY MILESTONE

Table 5: Key milestone

No	Detail / Week	Week														
		1	2	3	4	5	6	7		8	9	10	11	12	13	14
1	Discussion	■	■	■	■	■	■									
	a) Basic concept of processes	■	■													
	b) Designing		■	■	■	■	■	■		■						
	i) Modelling			■	■				Semester Break							
	ii) Equipment Selection				■	■	■									
	iii) Sizing					■	■	■		■						
2	Health & Safety Issues										■	■				
3	Economic Evaluation											■	■	■		
4	Report Submission & Presentation													■	■	■

3.4 GANTT CHART

Table 6: Gantt Chart

ACTIVITY	DURATION (month)	2009											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	De
Data	1												
a) Sampling	1												
b) Analysis	1												
Literature Review / Research Work	2												
Discussion	5												
a) Basic concept of processes	1												
b) Designing	4												
i) Modelling	1												
ii)Equipment Selection	1												
iii) Sizing	2												
Economic Evaluation	1												

CHAPTER 4

RESULTS AND DISCUSSION

4.1 RESULTS

4.1.1 Data gathering and sampling

Six samples are taken from PETRONAS Methanol (Labuan) Sdn Bhd from two points which are neutral basin point (the point where effluent being discharge directly from the basin) and effluent discharge point (the point where effluent has already flow in the drainage system).

Table 7: Data samples on 18 June 2008 at 1430 hours

Parameters	Unit	Neutral Basin	Effluent Discharge
Temperature	°C	38	38
pH		8.6	8.6
Free Chlorine	ppm	0.08	0.09
BOD	ppm	167.3	115.1
COD	ppm	77.5	65
Sulfide	ppm	Not Detectable	Not Detectable
T.S.S	ppm	21.8	17.4
Phenol	ppm	0.026	0.006
Oil/Grease	ppm	Not Detectable	Not Detectable
Cadmium	ppm	0.03	0.04
Chromium	ppm	0.03	0.12
Lead	ppm	Fog	
Copper	ppm	0.02	0.02
Manganese	ppm	0.04	0.02
Nickel	ppm	0.22	0.08
Zinc	ppm	0.06	0.01
Iron	ppm	0.41	0.18

Sampling Date: 18 June 2008
Sampling Time: 1430 Hrs

Table 8: Data samples on 6 July 2008 at 1930 hours

Parameters	**Unit**	**Neutral Basin**	**Effluent Discharge**
Temperature	°C	39	37
pH		8.8	8.8
Free Chlorine	ppm	0.097	0.279
BOD	ppm	91	130
COD	ppm	44	48
Sulfide	ppm	0.1145	0.2134
T.S.S	ppm	34.3	43.0
Phenol	ppm	0.054	0.009
Oil/Grease	ppm	0.70	0.35
Cadmium	ppm	0.015	0.008
Chromium	ppm	<0.01	<0.01
Lead	ppm	Fog	
Copper	ppm	<0.01	<0.01
Manganese	ppm	0.026	0.129
Nickel	ppm	0.056	0.043
Zinc	ppm	0.026	0.022
Iron	ppm	0.35	0.43

Sampling Date: 6 July 2008
Sampling Time: 1930 Hrs

Table 9: Data samples on 22 July 2008 at 0930 hours

Parameters	**Unit**	**Neutral Basin**	**Effluent Discharge**
Temperature	°C	29	29
pH		7.2	7.3
Free Chlorine	ppm	0.06	0.17
BOD	ppm	131	130
COD	ppm	33.2	49.8
Sulfide	ppm	Not Detectable	Not Detectable
T.S.S	ppm	15.6	19.6
Phenol	ppm	0.021	0.004
Oil/Grease	ppm	Not Detectable	Not Detectable
Cadmium	ppm	<0.01	<0.01
Chromium	ppm	<0.01	<0.01
Lead	ppm	<0.01	<0.01
Copper	ppm	<0.01	<0.01
Manganese	ppm	0.01	0.10
Nickel	ppm	0.01	0.001
Zinc	ppm	0.014	0.022
Iron	ppm	0.21	0.23

Sampling Date: 22 July 2008
Sampling Time: 0930 Hrs

Table 10: Data samples on 8 September 2008 at 1300 hours

Parameters	Unit	Neutral Basin	Effluent Discharge
Temperature	°C	33.4	32.3
pH		9.2	9.3
Free Chlorine	ppm	0.1	0.08
BOD	ppm	54.3	75.13
COD	ppm	48.2	52.18
Sulfide	ppm	0.2827	0.3174
T.S.S	ppm	19.79	5.96
Phenol	ppm	0.003	0.008
Oil/Grease	ppm	Not Detectable	Not Detectable
Cadmium	ppm	<0.01	<0.01
Chromium	ppm	<0.01	<0.01
Lead	ppm	0.16	0.14
Copper	ppm	<0.01	<0.01
Manganese	ppm	<0.01	NA
Nickel	ppm	<0.01	NA
Zinc	ppm	0.02	0.02
Iron	ppm	0.01	<0.01

Sampling Date: 8 September 2008
Sampling Time: 1300 Hrs

Table 11: Data samples on 25 October 2008 at 1030 hours

Parameters	Unit	Neutral Basin	Effluent Discharge
Temperature	°C	39	38
pH		7.6	7.6
Free Chlorine	ppm	<0.1	0.02
BOD	ppm	82.1	74.6
COD	ppm	51	34
Sulfide	ppm	0.0432	0.2614
T.S.S	ppm	16	38
Phenol	ppm	0.0009	0.012
Oil/Grease	ppm	Not Detectable	Not Detectable
Cadmium	ppm	<0.02	<0.02
Chromium	ppm	0.04	0.03
Lead	ppm	0.03	<0.5
Copper	ppm	<1.0	<1.0
Manganese	ppm	0.07	0.01
Nickel	ppm	0.04	0.01
Zinc	ppm	<1.0	0.06
Iron	ppm	0.36	0.66

Sampling Date: 25 October 2008
Sampling Time: 1030 Hr

Table 12: Data samples on 11 November 2008 at 0700 hours

Parameters	Unit	Neutral Basin	Effluent Discharge
Temperature	°C	40	38
pH		8.6	8.0
Free Chlorine	ppm	0.31	0.35
BOD	ppm	86.3	85.6
COD	ppm	21	5
Sulfide	ppm	Not Detectable	Not Detectable
T.S.S	ppm	5.6	1.0
Phenol	ppm	0.002	0.004
Oil/Grease	ppm	Not Detectable	Not Detectable
Cadmium	ppm	<0.02	<0.02
Chromium	ppm	0.03	<1.0
Lead	ppm	0.06	<0.5
Copper	ppm	<1.0	<1.0
Manganese	ppm	0.03	0.08
Nickel	ppm	0.04	<1.0
Zinc	ppm	<1.0	<1.0
Iron	ppm	0.19	0.07

Sampling Date: 11 November 2008
Sampling Time: 0700 Hrs

4.1.2 Data analysis

The parameters that are highlighted are temperature, pH, free Chlorine, BOD, COD, sulfide, Total Suspended Solids, phenol, oil/grease, Cadmium, Chromium, Lead, Cooper, Manganese, Nickel, Zinc, Iron. These parameters should meet the standard limit of Third Schedule in Environmental Quality (Sewage and Industrial Effluents) Regulations 1978.

Based on the analysis made, the parameters that comply with the Third Schedule are Temperature, Free Chlorine, COD, Sulfide, T.S.S, Phenol, Oil & Grease, Lead, Copper, Manganese, Nickel, Zinc and Iron. Meanwhile, the parameters that are not complying with the Third Schedule are pH, BOD, Cadmium and Chromium. Below are the graphs and analysis of the incompliance parameters.

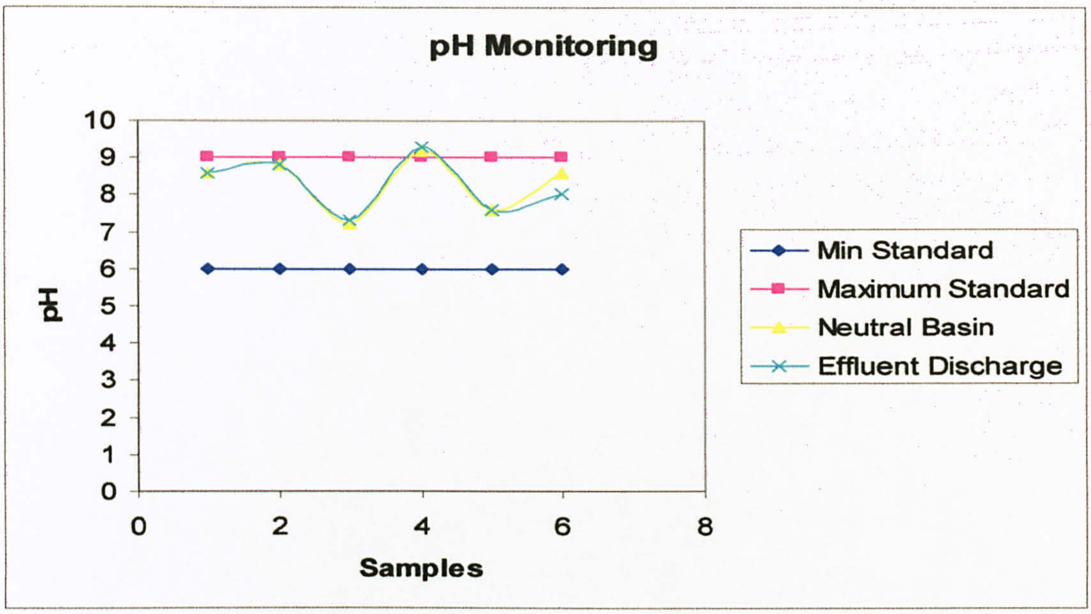

Figure 2: Graph of pH monitoring

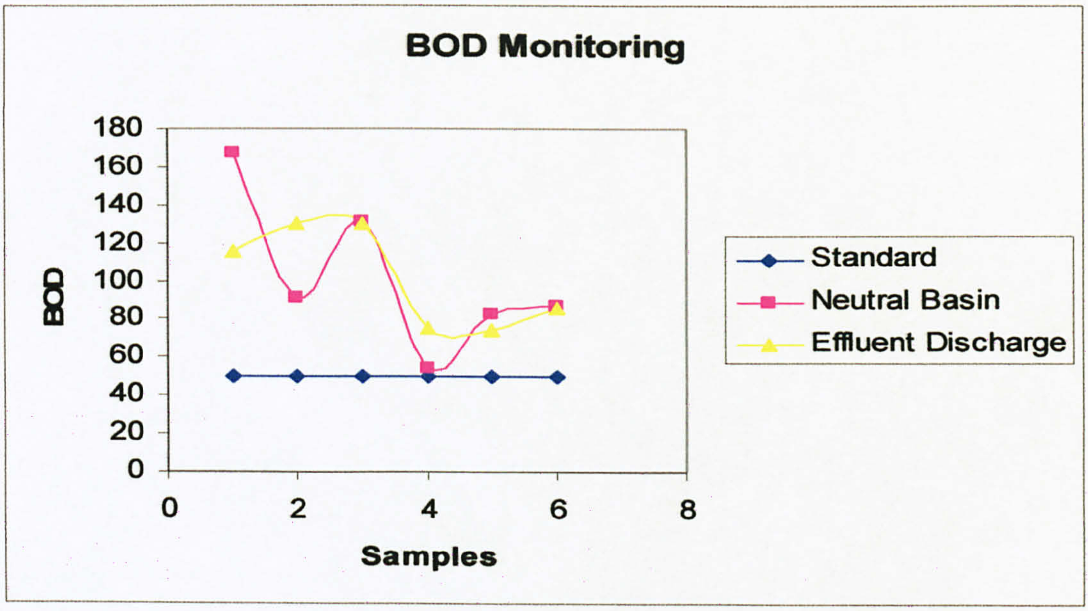

Figure 3: Graph of BOD monitoring

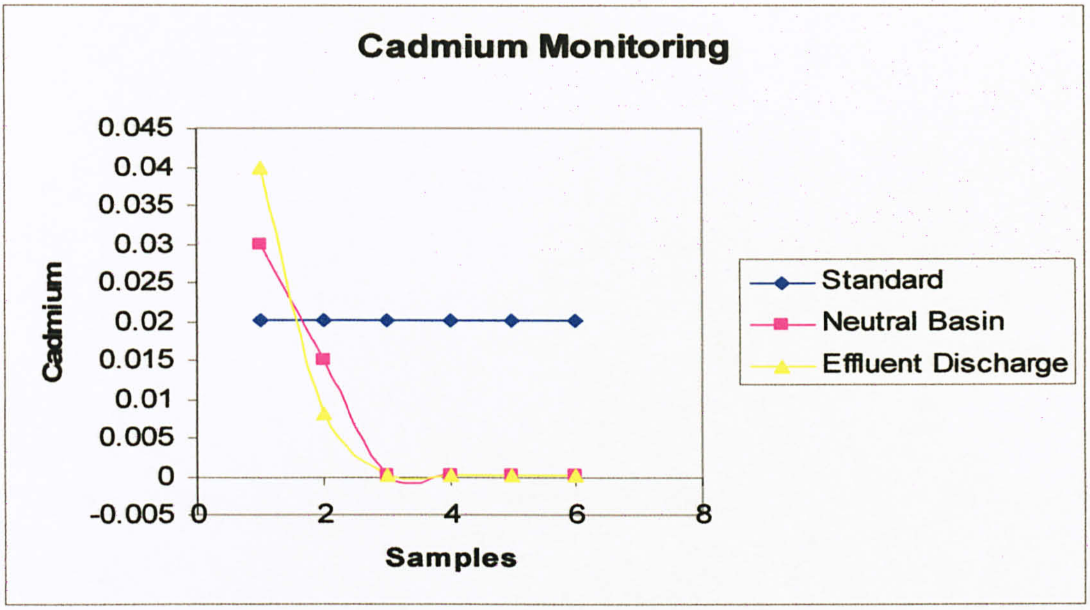

Figure 4: Graph of Cadmium monitoring

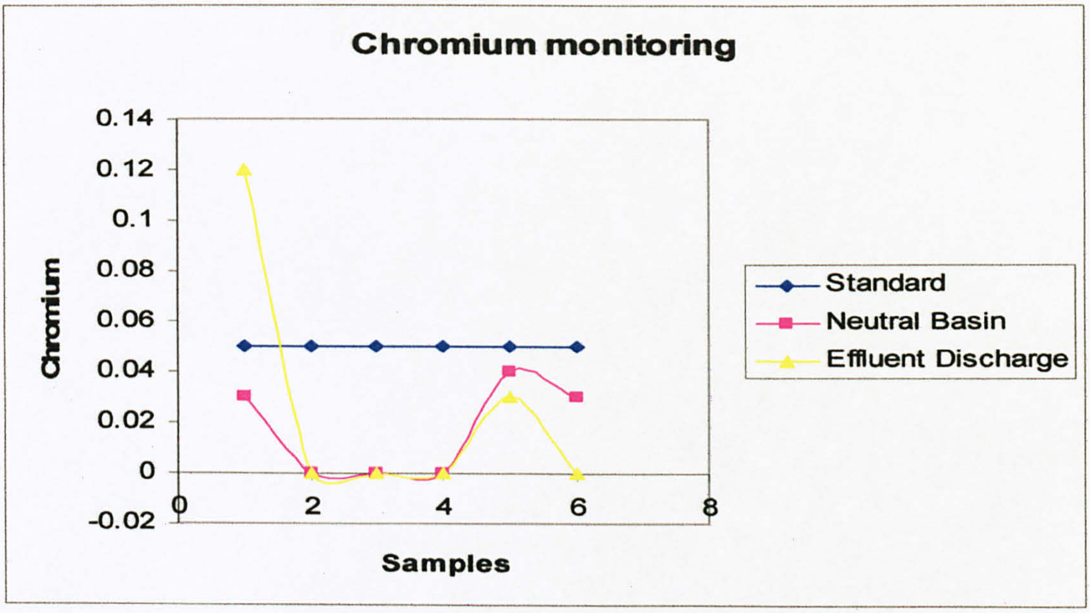

Figure 5: Graph of Chromium monitoring

PETRONAS Methanol (Labuan) Sdn Bhd should comply with the Standard B of Third Schedule. Therefore, for pH, the standard limit is in the range of 5.5 to 9.0. According to the graph, pH only exceeds on 8 September 2008 for both points. The values recorded are 9.2 for Neutral Basin and 9.3 for Effluent Discharge. Meanwhile, BOD is the parameter that exceeds the standard limit for all the samples taken. The highest value recorded is on 18 June 2008 which is 167.3 ppm for Neutral Basin point. The lowest value recorded is on 8 September 2008 which is 54.3 ppm for Neutral Basin point. However this value is still exceeding the standard limit. Both Cadmium and Chromium ions exceed the standard limit on 18 June 2008. Cadmium ion records the value 0.03 ppm for Neutral Basin point and 0.04 ppm for Effluent Discharge point. Meanwhile, Chromium ion is exceeding the standard limit with 0.12 ppm for Effluent Discharge point.

Table 13: Summarization of the exceeding parameters

Date of Sampling	Parameters
18 June 2008	BOD, Cadmium, Chromium
6 July 2008	BOD
22 July 2008	BOD
8 September 2008	BOD, pH
25 October 2008	BOD, Chromium
11 November 2008	BOD, Chromium

Table above shows the summarization of the parameters that exceed the standard limit of Third Schedule in Environmental Quality (Sewage and Industrial Effluents) Regulations 1978 based on the date of sampling. From the table, BOD exceeds for all samples. Meanwhile COD do not comply with the standard limit on 18 June 2008, 8 September 2008 and 25 October 2008. Chromium exceeds for the three data samples. However, Cadmium, Sulfide and pH just exceed for a sample taken.

4.2 DISCUSSION

4.2.1 Findings

From data analysis, we can highlight the main problem encountered by the company. The effluent that is being discharged from PM(L)SB is having high concentration of BOD. The other parameters are the minor problems. Therefore, a solution towards the problem is to have a water treatment unit mainly to remove BOD. In that case, the design of the water treatment unit should be based on the BOD removal.

A thorough study has been done on the BOD removal treatment. It is suggested to use biological treatment processes. There are two types of main categories of biological treatment processes which are suspended growth and attached growth processes. [2] In suspended growth processes, the microorganisms responsible for treatment are maintained in liquid suspension by appropriate mixing methods. Meanwhile, in attached growth processes, the microorganisms responsible for the conversion of organic material or nutrients are attached to an inert packing material. Packing materials used in attached growth processes include rock, gravel, slag, sand, redwood and plastic. In suspended growth processes, there are several types of treatment process which are suspended activated-sludge process and suspended growth aerated lagoons. [2] For attached growth processes, the types of treatment are trickling filters, rotating biological contactors and packed-bed reactors. [2] There is also a combination between attached growth and suspended growth process.

So, for this case, it is suggested to use suspended growth process. For suspended growth process, the type of treatment to be used is activated-sludge process. The reason behind of using biological treatment process is because the parameter that needs to be considered most is the biological oxygen demand (BOD).

Below are the descriptions of activated-sludge processes for BOD removal:

1. Complete-mix activated-sludge (CMAS) [2]

   The CMAS process is an application of the flow regime of a continuous flow stirred-tank reactor. Settled wastewater and recycled activated sludge are introduced typically at several points in the aeration tank. The organic load at the aeration tank, mixed-liquor suspended solids (MLSS) concentration and oxygen demand are uniform throughout the tank. An advantage of the CMAS process is the dilution of shock loads that occur in the treatment of industrial wastewaters. The CMAS process is relatively simple to operate but tends to have low organics substrate concentrations that encourage the growth of filamentous bacteria, causing bulking problems

2. Conventional Plug Flow [2]

   Settled wastewater and return activated sludge (RAS) enter the front end of the aeration tank and are mixed by diffused air or mechanical aeration. Typically, from 3 to 5 channels (passes) are used. During the aeration period, adsorption, flocculation, and oxidation of organic matter occur. Activated-sludge solids are separated in a secondary settling tank.

3. Sequencing batch reactor (SBR) [2]

   The SBR is a fill-and-draw type of reactor system involving a single complete-mix reactor in which all steps of the activated-sludge process occur. For municipal wastewater treatment with continuous flow, at least 2 basins are used so that one basin is in the fill mode while the other goes through react, solids settling and effluent withdrawal. An SBR goes through a number of cycles per day.

From this information, the type of treatment should be selected. However, there some parameters need to be considering such as the flow rate of the effluent and the space available at the plant.

In activated sludge process, organic matter is removed from solution by biological metabolism, oxygen is consumed by the organisms and new cell mass is synthesized.[7] However for the effluent that contains other parameters apart from BOD, the treatment should involve principles also such as ion exchange or filtration. Usually, pH is controlled through neutralization and oil and grease removal. If suspended solids are present in the wastewater, it is desirable to remove these through sedimentation or flotation.[7] Suspended solids need to be removed because it will reduce the active biomass content of the sludge and will render the waste sludge more difficult to thicken and dewater. Heavy metals should be removed to avoid high metal content in the waste-activated sludge.

4.2.2 Modelling

Figure 6: Overview of flow of activated sludge process treatment of industrial wastewater.

As an overview, in these three stages of treatment, the effluent discharge should follow through the minor stages as it requires.

a) Pretreatment

Pretreatment is designed to handle any wastewater characteristics that are not compatible with optimal performance of the activated sludge process [7]. Pretreatment involves:-

- Neutralization
- Suspended solids
- Oil and grease
- Heavy metals
- Organic toxics

Table 14: Pretreatment types for certain parameters

Pollutant or System Condition	Kind of Pretreatment
Suspended solids	Sedimentation, flotation, lagooning
Oil and Grease	Skimming tank or separator
Toxic ions (Pb, Cu, Ni, CN, Cr^{+6}, Zn, Cr^{+3})	Precipitation or ion exchange
pH	Neutralization
Sulfides	Precipitation or stripping with recovery
Phenols	Extraction, adsorption
Temperature	Cooling, steam addition

b) Activated Sludge Process

In activated sludge process, organic matter is removed from solution by biological metabolism, oxygen is consumed by the organisms and new cell mass is synthesized. It involves:-

- Sludge Bulking Control
- BOD and COD Removal
- Sludge Production
- Oxygen Requirements
- Nitrification and Denitrification
- Toxicity Removal

c) Final Clarifier

Clarifier is one of the important stages, where the excess sludge will be discharge. So, final clarifier involves:-

- Solids Flux
- Effluent Suspended
- Solids Control

From the above descriptions, the detail design of water treatment unit in PM(L)SB will as figure below:-

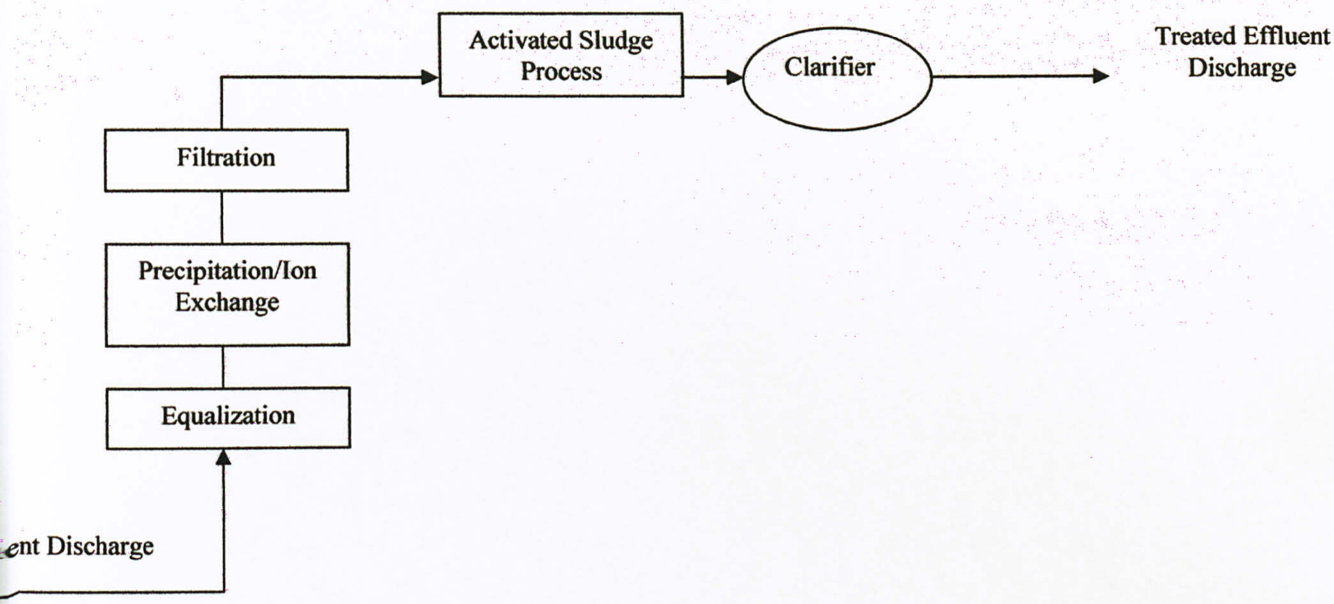

Figure 7: Proposed design of activated sludge process treatment

4.2.2.1 Pre-Treatment Design

To make sure the activated sludge process runs in an efficient operation, it requires control toxic substances, incompatible pollutants such as acids/bases, oil and grease and fluctuations in hydraulic and organic loads through a variety of pre-treatment technologies.

i. *Equalization*

Most industrial wastewater discharges fluctuate in flow rate and pollutant loading with time due to batch processing. Equalization is therefore required to dampen these fluctuations and maintain stable operation of the treatment processes. The equalization basin should be completely mixed and can be operated in either a constant volume (variable outflow) or variable volume (constant outflow) mode. If the wastewater flow rate remains constant with time, a constant volume basin will provide adequate load equalization. By contrast, a plant employing batch production processes with rapid changes in both flow and pollutant load should employ a variable volume basin with a constant volumetric withdrawal rate.

Equalization basin volume requirements can be determined based on a materials balance around the tank. Continuous flow, complete mix conditions are assumed with no removal of BOD or TSS or chemical reaction within the tank. The materials balance, neglecting the effects of evaporation, is expressed as:-

$$\frac{d(CV)}{dt} = C\frac{dV}{dt} + V\frac{dC}{dt} \qquad [4]$$

C = Effluent (and tank) concentration, mg/L

V = Tank wet volume, MG

For the case of a fixed volume equalization tank (V = constant) :-

$$C_t = C_i(1 - exp)^{-z} + C_{t-1}exp^{-z} \qquad [5]$$

Since, PETRONAS Methanol (Labuan) Sdn Bhd, employs a batch production process, they should implement a variable volume equalization tank. By developing equation above:-

$$C_t = \frac{Q_iC_i\Delta t + V_tC_{t-1}}{Q_i\Delta t + V_t} \qquad [6]$$

V = Equalization tank volume, MG

C_i = Influent concentration, mg/L

Q_i = Influent flow, MG/hr

C_t = Effluent (and tank) concentration at time = t

C_{t-1} = Effluent (and tank) concentration at time = t - 1

Δt = Sampling interval, hr

The change of storage volume (V_t) in the variable volume tank during Δt is given by:-

$$V_t = (Q_i - q_P)\Delta t + V_{t-1} \text{.......................................} [7]$$

q_P = Effluent flow rate, MG/hr

Δt = Sampling interval, hr

C_{t-1} = Concentration in effluent/tank at previous time interval, mg/L

V_{t-1} = Tank wet volume at previous time interval, MG

Sizing of the equalization tank volume requires hourly (Δt) measurements of the flow rate (Q_i) and concentration (C_i) of the raw wastewater over a representative production cycle.

ii. pH Neutralization

The activated sludge process operates most effectively over a pH range of 6.5 to 8.5 and neutralization may be required for wastewaters that are outside this pH range. There are exceptions, however in which highly alkaline or acidic wastewaters do not require pH adjustments for effective treatment by activated sludge.

iii. Precipitation and Ion Exchange (Heavy metals)

Heavy metals are important because they are often toxic and they impede or interfere with the biological treatment process. Depending upon the metal and the species, all the reactions are pH dependent. When optimizing multiple metal removals in a waste species, usually it is necessary to have a two-step process for pH removal. For example, chromium and zinc, they may need separate pH tanks for treatment.

Hexavalent chromium, Cr^{6+} has high aquatic toxicity and is a human and animal carcinogen. In the 6+ valence, it is too soluble to be effectively removed by conventional precipitation. Therefore, it must be reduced either by reaction with Ferrous ions or by treatment with a sulfite such as Na_2S or with H_2S in gaseous form. Cadmium is difficult to reclaim and even worst to dispose of. It is moderately easy to precipitate either as a hydroxide or as a sulfide. In wastewater treatment facilities, metals are precipitated most commonly as metal hydroxides through addition of lime or caustic to a pH minimum solubility.

Using the complete – mix reactors in with reaction, the steady – state solution is of concern as it is used for design.

$$Accumulation = inflow - outflow + generation$$

$$\frac{dC}{dt}V = QC_0 - QC + r_cV \text{.......................................[8]}$$

At steady state

$$\frac{dC}{dt} = 0 \text{...[9]}$$

Rearranging [8] and [9]

$$C = \frac{C_0}{\left[1+k\left(\frac{V}{Q}\right)\right]} \qquad \text{[11]}$$

$$\frac{V}{Q} = \tau \qquad \text{[11]}$$

$$C = \frac{C_0}{1+k\tau} \qquad \text{[12]}$$

iv. Filtration

Heavy metals are important because they are often toxic and they impede or interfere with the biological treatment process. Depending upon the metal and the species, all the reactions are pH dependent. When optimizing multiple metal removals in a waste species, usually it is necessary to have a two-step process for pH removal. For example, chromium and zinc, they may need separate pH tanks for treatment.

4.2.2.2 Activated – Sludge Process and Final Clarifier

Principles of Biological Treatment systems

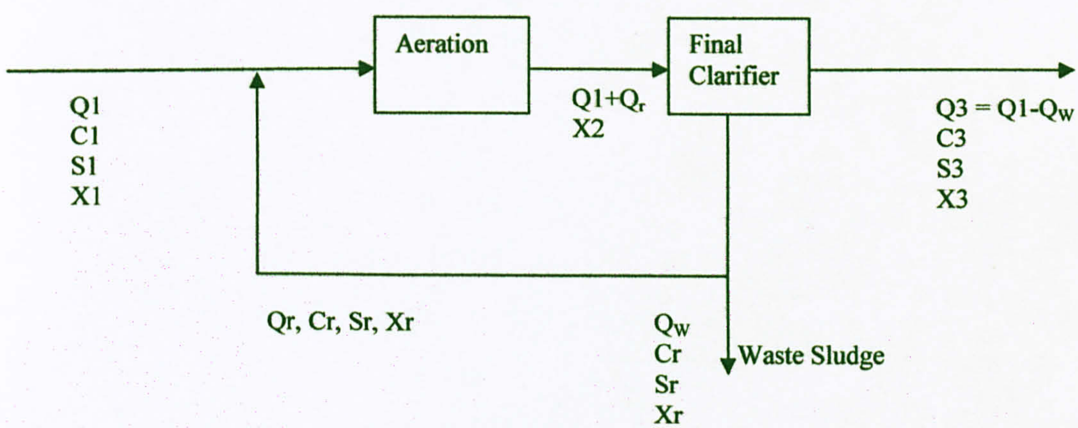

Figure 8: Activated – sludge process

The diagram above is a representation of an activated sludge process system. Below are the terms used in the diagram representation and equations.

Q = Volumetric influent rate (volume/time)

Q_w = Waste Sludge volumetric flow rate (volume/time)

Q_3 = Effluent flow rate (volume/time)

Q_r = Recycle flow rate

X_1 = Microorganism influent concentration (mass/volume influent)

X_2 = Aeration basin microorganism concentration (mass/volume)

X_3 = Secondary effluent microorganism concentration (mass/volume)

X_r = Recycle and wasted solids concentration

V_2 = Aeration basin volume

r_{BH} = Reaction rate for solid also may be written as dX/dt = rate of change of microorganism concentration in aeration basin (mass/volume time)

r_s = Reaction rate for substrate

Y = Yield substrate

$$Q_1X_1 + VX_2r_2 = Q_3X_3 + Q_wX_r \qquad [13]$$

$$\mu = r_2 = \frac{Q_3X_3+Q_WX_r}{V_2X_2} \qquad [14]$$

$$X_2 = Y(X_1 - X_3) \qquad [15]$$

If there are no recycle, Q_w = 0, then it will be reduced to

$$Q_1X_1 + VX_2r_2 = Q_3X_3 \qquad [16]$$

Biological sludge from industrial wastewater treatment may vary significantly from municipal sludge. This will influence the design of the final clarifier. High dispersed effluent suspended solids are frequently encountered, requiring the application of chemicals for their removal.

Calculation on the volume of the tank:-

i. Assume no recycle stream, $Q_w = 0$
ii. Assume the Flow rate of the effluent = 2.0 MGD = 0.083 MGH = 7570 m^3/D
iii. Assume BOD concentration to be reduced (X_3) = 10 mg/l
iv. Influent concentration (X_1) = 115.1 mg/l
v. Assume, Yield for substrate, Y = 0.4 kg BOD of bacteria per kg of substrate consumed
vi. Assume, r_b = 3 kg of substrate consumed per kg of bacteria

Rearranging the equation,

$$V = \frac{[Q_1X_1 - Q_3X_3]}{r_bX_b}$$

$$X_b = Y(X_1 - X_3)$$
$$X_b = 0.4(115.1 - 10)$$
$$X_b = 42.04$$

And

$$V = \frac{[(7570 \times 115.1) - (7570 \times 10)]}{3 \times 42.04}$$
$$V = 6308.33\ m^3$$

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

BOD is found to be the critical parameter since it exceeds all the samples taken. Therefore, biological wastewater treatment is one suitable method to reduce the BOD. Theoretically, BOD is simply measure of the amount of oxygen that is consumed over a period of 5 days. [5] BOD need to be removed since it would cause problems to the environment especially the water. Higher level of BOD could lead to the death of aquatic life. The type of biological wastewater treatment to be used is the activated sludge process. Activated sludge process is effective enough to remove about 95 – 98% of BOD. However, the treatment unit should consist of pre-treatment because the effluent contains the other exceeding parameters. In calculating and determining the volume of the tank used, concentration and the wastewater flow rate are needed. Volume of the tank will determine the size of the tank needed. Size of the tank is important because it shows how much space is needed in building a new water treatment unit.

5.2 RECOMMENDATIONS

1. Further study on the recycle stream of the excess sludge need to be done for future recommendation.
2. Materials selection of the tanks needs to be considered.

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APPENDIX

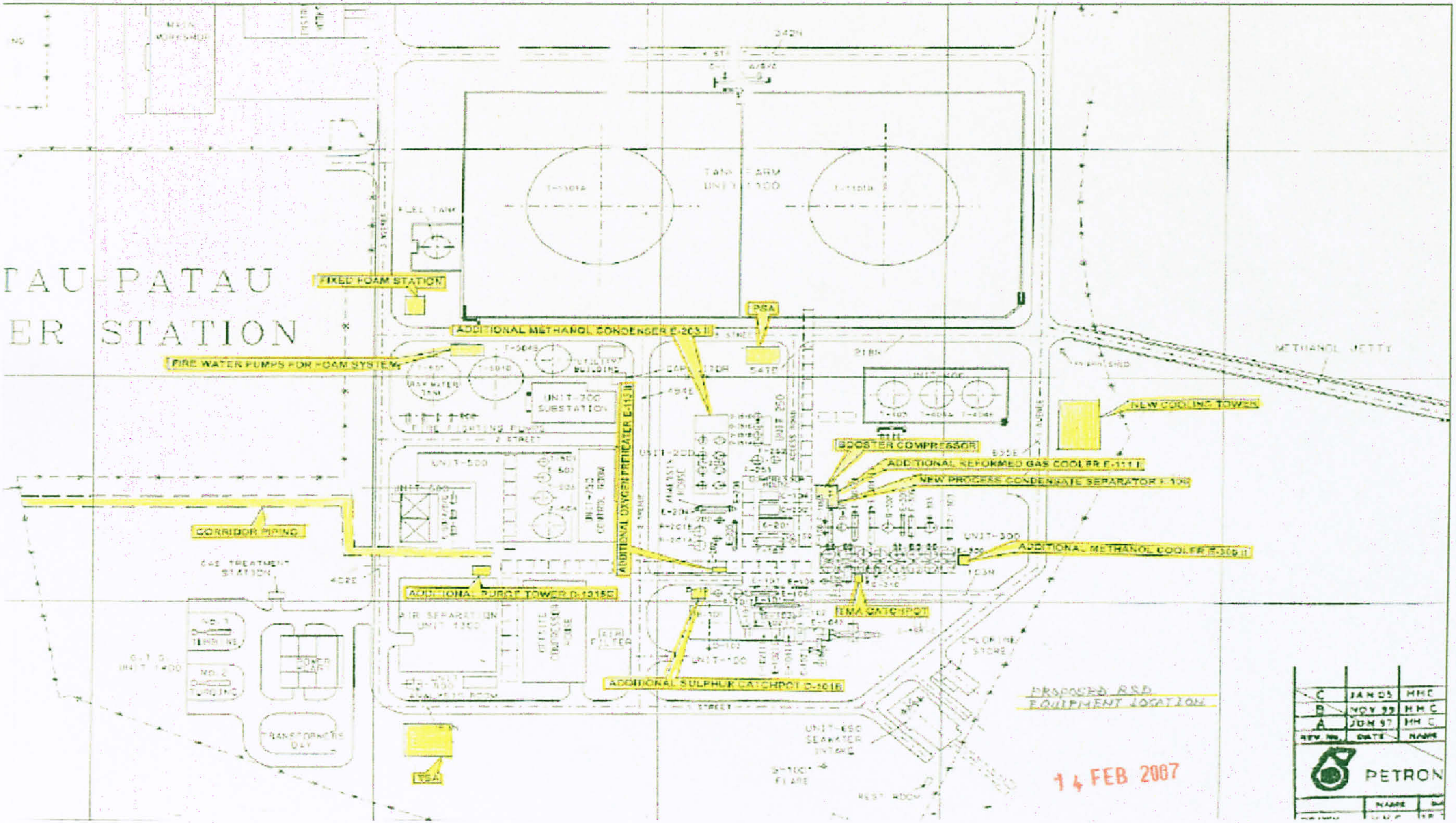

Figure 9: Layout of PETRONAS Methanol (Labuan) Sdn Bhd

FEDERAL SUBSIDIARY LEGISLATION

ENVIRONMENTAL QUALITY ACT 1974 *[ACT 127]*

P.U.(A) 12/79

ENVIRONMENTAL QUALITY (SEWAGE AND INDUSTRIAL EFFLUENTS) REGULATIONS 1979

Incorporating latest amendments - P.U.(A) 398/2000

Publication : 1st February 1979
Date of coming into operation : 1st January 1981

ARRANGEMENT OF REGULATIONS

PART III - ACCEPTABLE CONDITIONS OF DISCHARGE INTO INLAND WATERS

PART IV - DISCHARGE OF EFFLUENT AND SLUDGE ONTO LAND

PART V - LICENCE FOR CONTRAVENTION OF ACCEPTABLE CONDITIONS

PART VI - MISCELLANEOUS

PART VII - FEES

Preamble

IN exercise of the powers conferred by section 51 of the Environmental Quality Act 1974 [*Act 127*], the Minister, after consultation with the Environmental Quality Council, makes the following regulations :

PART I - PRELIMINARY

Regulation 1. Citation and commencement

(1) These Regulations may be cited as the **Environmental Quality (Sewage and Industrial Effluents) Regulations 1979.**

(2) These Regulations shall be deemed to have come into force on 1st January 1979; except for those sources in existence before this date, these Regulations shall come into force on January 1, 1981.

Regulation 2. Interpretation.

In these Regulations, unless the context otherwise requires-

"effluent" means sewage or industrial effluent;

"industrial effluents" means liquid water or wastewater produced by reasons of the production processes taking place at any industrial premises;

"inland waters" include any reservoir, pond, lake, river, stream, canal, drain, spring or well, any part of the sea abutting on the foreshore, and any other body of natural of artificial surface or subsurface water;

"licence" means a licence which a person may obtain for the purposes of section 25 of the Act;

"licence premises " means premises occupied by a person who is the holder of a licence issued in respect of the premises;

"parameter" means any of the factors shown in the first column of the Third Schedule or in the Fifth Schedule and any others factors which the Director-General may specify in accordance with the provisions of paragraph (4) of regulation 8;

"sewage" means any liquid waste or wastewater discharge containing animal or vegetable matter in suspension or solution, and may include liquids containing chemicals in solution;

"sewer" means any line of pipes or channels with their appurtenances designed and used to convey effluent;

"sewerage system" means a system incorporating sewers and all other structures, devices, equipment, appurtenances intended for the collection, transportation, and pumping of effluents including a treatment plant;

"treatment plant" means any facility for the conditioning of effluent to effect reduction or partial reduction of its potential to cause pollution.

Regulation 3. Application.

These Regulations shall apply to discharges of effluent into any inland waters, other than the effluents discharged from prescribed premises or other premises specified in the First Schedule or both.

PART II - NEW SOURCES OF DISCHARGE

Regulation 4. Prohibition against new and altered sources of effluent discharge.

Notwithstanding any other provisions of these Regulations, no person without prior written permission of the Director-General shall-

(1) carry out any work on any premises that may result in a new source of effluent discharge or cause a material change in the quantity or quality of the discharge from an existing sources; or

(2) construct on any land any building designed or used for a purpose that may cause the land or building to result in a new source of effluent discharge.

Regulation 5. Requirement and approval of plans.

(1) An application to carry out any work, building, erection or alteration specified in regulation 4 shall be submitted to the Director-General in the prescribed form and shall be accompanied by the prescribed fee under regulation 21.

(2) The Director-General may grant such application either subject to conditions or unconditionally and may require the applicant-

(*a*) to repair, alter, replace or install control equipment;

(*b*) to conduct a monitoring programme at his own expense or bear the cost of such programme within such period or at such time and in such manner as the Director-General may specify.

PART III - ACCEPTABLE CONDITIONS OF DISCHARGE INTO INLAND WATERS

Regulation 6. Prohibition of discharge of effluent containing certain substances

No person shall discharge or cause or permit the discharge of any of the following substances into any inland waters:

(1) any inflammable solvent;

(2) any tar or other liquids immiscible with water;

(3) refuse, garbage, sawdust, timber, human or animal waste or solid matters.

Regulation 7. Standard Methods of analysis of effluents

For the purposes of these Regulations, the effluent discharged into any inland waters shall be analysed in accordance with the nineteenth edition of the methods specified in the Second Schedule, or in accordance with such other methods of analysis as the Director-General thinks fit.

[Am. P.U.(A) 400/97]

Regulation 8. Parameter limits of effluent to be discharged into inland waters

(1) No person shall discharge effluent, analysed in accordance with regulation 7, which contains substances in concentrations greater than those specified as parameter limits of-

(*a*) Standard A, as shown in the third column of the Third Schedule, into any inland waters within the catchment areas specified in the Fourth Schedule; or

(*b*) Standard B, as shown in the fourth column of the Third Schedule, into any other inland waters.

(2) Where two or more of the metals specified as parameters (xii) to (xvi), pursuant to paragraph (1) of this regulation, are present in the effluent, the concentration of these metals shall not be greater than-

(*a*) 0.5 milligrammes per litre in total, where Standard A is applicable;

(*b*) 3.0 milligrammes per litre in total, and 1.0 milligramme per litre in total for soluble forms, where Standard B is applicable.

(3) Where Standard B is applicable and when both phenol and free chlorine are present in the same effluent, the concentration of phenol individually, shall not be greater than 0.2 milligrammes per litre and the concentration of free chlorine individually, shall not be greater than 1 milligramme per litre.

(4) Where the Director-General deems it necessary , he may by notice in writing specify the acceptable conditions of discharge including the parameter limits of effluent, with respect to any or all of the parameters specified in the Fifth Schedule and any other parameters not listed anywhere in these Regulations.

PART IV - DISCHARGE OF EFFLUENT AND SLUDGE ONTO LAND

Regulation 9. Restrictions on the discharge of effluents

No person shall discharge or cause or permit the discharge of any effluent in or on any soil or surface of any land without the prior written permission of the Director-General.

Regulation 10. Restrictions on disposal sludges.

No person shall discharge or cause or permit the discharge of any solid waste or sludge that is generated from any production or manufacturing processes or from any effluent treatment plant in or on any soil or surface of any land without the prior written permission of the Director-General.

PART V - LICENCE FOR CONTRAVENTION OF ACCEPTABLE CONDITIONS

Regulation 11. Acceptable conditions which may be contravened.

(1) In accordance with the provisions of section 25 (1) of the Act, application for a licence may be made for the purposes of the contravention of acceptable conditions of effluent discharge specified in regulation 8.

(2) An application for a licence shall be made in accordance with the procedures specified in the Environmental Quality (Licensing) Regulations 1977 *[P.U.(A) 198/77]*.

(3) The Director-General may refuse to grant the application for a licence if he is satisfied that the granting of application for such a licence is likely to cause a worsening of condition in the inland waters or cause pollution in any other segment or element of the environment.

(4) Without prejudice to the generality of paragraph (3) of this regulation, the Director-General may grant the application for a licence if he is satisfied that-

(a) there is no known practicable means of control to enable compliance with the acceptable conditions; or

(b) the estimated cost to be incurred for compliance will be prohibitive having regard to the nature and size of the industry, trade, or process being carried out in the premises discharging the influent; or

(c) the design and construction of any treatment plant or other control equipment and their commissioning require a longer period than the period for compliance with these Regulations; or

(d) the imposition of the acceptable conditions as prescribed may result in circumstances which, in his opinion and having regard to all factors, are not reasonably practicable or are contrary to intent and spirit of the Act; or

(e) a sewerage system is to be provided and the effluent is permitted to be admitted into the sewerage system

(5) For the purpose of subparagraph (4) (e), in imposing conditions on a licence limiting the parameters of effluent to be discharged, the Director-General shall be guided-

(a) by the parameter limits of Standards B in respect of the discharge into any inland waters specified in regulation 8 (1)(*a*); or

(b) by the perameter limits specified in the Sixth Schedule in respect of the discharge into any other inland waters.

Regulation 12. Reporting changes in Information furnished for purposes of application.

An applicant for a licence or for the renewal or transfer of a licence shall, within seven days of the occurrence of any material change in any information furnished in his application or furnished in writing pursuant to a request by the Director-General under section 11 (2) of the Act give the Director-General a report in writing of the change.

Regulation 13. Making changes that alter quality of effluent.

(1) The holder of licence shall not make, or cause or permit to be made, any change to the premises or in the manner of running, using, maintaining or operating the premises or in any operation or process carried on at the premises, which change causes, or is intended or is likely to cause, a material increase in the quantity or quality of effluent or both discharged from the premises, unless prior written approval of the Director-General has been obtained for the change.

(2) For the purposes of paragraph (1), changes to licensed premises include-

(*a*) any change in the construction, structure, or arrangement of the premises or any building serving the premises;

(*b*) any change in the construction, structure, arrangement, alignment, direction, or condition of any channelling device, system, or facility serving the premises; and (*c*) any change of, to, or in any plant, machine, or equipment used or installed at the premises.

Regulation 14. Display of licence.

The holder of a licence shall display his licence, together with every document forming part of the licence, in a conspicious position in the principal building of the premises.

Regulation 15. Continuance of existing conditions and restrictions in case of change in occupancy.

Where a person becomes the occupier of licensed premises in succession to another person who holds a yet unexpired licence in respect of the premises, then-

(1) for a period of fourteen days after the change in occupancy; or

(2) where the new occupier to makes an application within that period for the transfer to him of the licence, for the period from the change in occupancy until final determination of his application,

the conditions and restrictions of the licence shall be binding on the new occupier and shall be observed by him, notwithstanding that he is not yet the holder of the licence or that the licence may, during the period specified in paragraph (1) or (2), as the case may be, have expired.

PART VI – MISCELLANEOUS

Regulation 16. Point of discharge

(1) The point or points of discharge of effluent shall be determined by the Director-General.

(2) The position and design of the outlet at the point or points of discharge of effluent into any inland waters or onto any land as determined in paragraph (1) shall not be altered or changed without the prior written approval of the Director-General.

(3) Wherever the concentration of any parameter of effluent discharged or to be discharged is mentioned in these Regulations, the reference, unless the context otherwise requires, is to the concentration as at the point of discharge determined in paragraph (1).

Regulation 17. Dilution of effluent

No person shall dilute, or cause or permit to be diluted, any effluent, whether raw or treated at any time or point after it is produced at any premises unless prior written authorisation of the Director-General has been obtained for the dilution and the dilution is done according to the terms and conditions of the authorisation.

Regulation 18. Spill or accidental discharge

(1) In the event of the occurrence of any spill or accidental discharge of the substances specified in regulation 8 which either directly or indirectly gains or may gain access into any inland waters, the person or persons responsible for such occurrence shall immediately inform the Director-General of the occurrence.

(2) The person or persons responsible for the occurrence of the spill or accidental discharge referred to in paragraph (1) shall be required, to every reasonable extent, to contain, cleanse or abate the spill or accidental discharge or to recover substances involved in the spill or accidental discharge in a manner satisfactory to the Director-General.

(3) The Director-General shall estimate any damage caused by the spill or accidental discharge and may recover all costs and expenses from the person or persons responsible for the occurrence of the spill or accidental discharge.

Regulation 19. Provisions for inspection.

A person who discharges effluent into any inland waters or onto any land shall, in connection with such discharge, install such sampling test point or points, inspection chambers, flow-meters, and recording and other apparatuses as the Director-General may, from time to time, require.

Regulation 20. Occupier to render assistance during inspections.

An occupier of any premises shall provide the Director-General or any other officer duly authorised in writing by him every reasonable assistance or facility available at premises, including labour, equipment, appliances, and instruments that he may require for the purpose of taking any action that he is empowered by section 38 of the Act to take respect of the premises.

PART VII – FEES

Regulation 21. Fee for written permission.

The fee for a written permission under regulation 4 is $100.00.

Regulation 22. Fee for licence including renewal of licence.

(1) The fee for a licence, including the renewal of a licence , is $100.00 plus an effluent-related amount computed according to the method prescribed in Seventh Schedule.

(2) The fee of $100.00 shall accompany the application and shall not be refundable.

(3) The effluent-related amount shall not become due until called for.

Regulation 23. Waiver of fee

(1) If the Director-General is satisfied that research on effluent disposal or treatment of a kind or scale that is likely to benefit the cause of environmental protection is being or is to be carried out at any licensed premises, he may, with the approval of the Minister, wholly or partly waive any effluent-related amount payable by virtue or regulation 22 (3).

(2) In deciding on the extent of waiver, the Director-General shall be guided-

(a) by a consideration of how much of the amount of effluent discharged or to be discharged is involved in the research; or

(b) by a consideration of the physical and chemical characteristics of the effluent discharged or to be discharged.

Regulation 24. Fee for transfer of licence

The fee for a transfer of licence is $30.00.

FIRST SCHEDULE

ENVIRONMENTAL QUALITY ACT 1974

ENVIRONMENTAL QUALITY (SEWAGE AND INDUSTRIAL EFFLUENTS) REGULATIONS 1978

[Regulation 3]

LIST OF DISCHARGES TO WHICH THESE REGULATIONS DO NOT APPLY

Subject to the provisions of regulation 6, these Regulations shall not apply to discharges of effluent into any inland waters from the following sources:

1. Processing of oil-palm fruit or oil-palm fresh-fruit bunches into crude palm oil, whether as an intermediate or final product;

2. Processing of natural rubber in technically specified form, latex form including prevulcanised or the form of modified and special purpose rubber, conventional sheet, skim, crepe or scrap rubber;

3. Mining activities;

4. Processing, manufacturing, washing, or servicing of any other products or goods-

(1) that produce effluent of less than 60 cubic meters (13,000 imperial gallons) per day;

(2) that the effluent of which does not contain those contaminants listed as parameters (vi) to (vii) in the first column of the Third Schedule;

(3) where the total load of biochemical oxygen demand of the effluent fixed at 20 degrees Centigrade for 5 days or suspended solid or both, shall not exceed 6 kilograms per day (concentration 100 milligrammes per litre);

(4) in any housing or commercial development or both of less than 30 units, without affecting the generality of 4 (3).

SECOND SCHEDULE

ENVIRONMENTAL QUALITY ACT 1974

ENVIRONMENTAL QUALITY (SEWAGE AND INDUSTRIAL EFFLUENTS) REGULATIONS 1978

[Regulation 7]

STANDARDS METHODS OF ANALYSIS OF EFFLUENT

1. "Standard Methods for the Examination of Water and Wastewater" published jointly by the American Public Health Association, the American Water Works Association and the Water Pollution Control Federation of the United States; or

2. *[Deleted by P.U.(A) 400/97]*

THIRD SCHEDULE

ENVIRONMENTAL QUALITY ACT 1974

ENVIRONMENTAL QUALITY (SEWAGE AND INDUSTRIAL EFFLUENTS) REGULATIONS 1978

[Regulation 8 (1), 8 (2), 8 (3)]

PARAMETER LIMITS OF EFFLUENT OF STANDARDS A AND B

Parameter	*Unit*	*Standard*	
		A	*B*
(*1*)	(*2*)	(*3*)	(*4*)
(I) Temperature	^oC	40	40
(ii) pH Value	-	6.0-9.0	5.5-9.0
(iii) BOD_5 at 20^oC	mg/1	20	50
(iv) COD	mg/1	50	100
(v) Suspended Solids	mg/1	50	100
(vi) Mercury	mg/1	0.005	0.05
(vii) Cadmium	mg/1	0.01	0.02
(viii) Chromium, Hexavalent	mg/1	0.05	0.05
(ix) Arsenic	mg/1	0.05	0.10
(x) Cyanide	mg/1	0.05	0.10
(xi) Lead	mg/1	0.10	0.5
(xii) Chromium, Trivalent	mg/1	0.20	1.0
(xiii) Copper	mg/1	0.20	1.0
(xiv) Manganese	mg/1	0.20	1.0
(xv) Nickel	mg/1	0.20	1.0
(xvi) Tin	mg/1	0.20	1.0

(xvii) Zinc	mg/1	2.0	2.0 *[Am. P.U.(A) 398/2000]*
(xviii) Boron	mg/1	1.0	4.0
(xix) Iron (Fe)	mg/1	1.0	5.0
(xx) Phenol	mg/1	0.001	1.0
(xxi) Free Chlorine	mg/1	1.0	2.0
(xxii) Sulphide	mg/1	0.50	0.50
(xxiii) Oil and Grease	mg/1	Not detectable	10.0

FOURTH SCHEDULE

ENVIRONMENTAL QUALITY ACT 1974

ENVIRONMENTAL QUALITY (SEWAGE AND INDUSTRIAL EFFLUENTS) REGULATIONS 1978

[Regulation 8 (1)]

LIST OF CATCHMENT AREAS WHERE STANDARD A APPLIES

1. The catchment areas referred to in this regulation shall be the areas upstream of surface or above sub-surface water supply intakes, for the purpose of human consumption including drinking.

2. For the purpose of this regulation, the water supply intakes shall include the public water supply intakes specified below;

(1) The state of Johor

Location for Water Intake		*Name of River/ Reservoir/Well*	*Water Supply Scheme*
(1)		*(2)*	*(3)*
Longitude(East)	*Latitude(North)*		

103° 26' 00"	1° 34' 00"	Sg.Air Hitam	Pontian
103° 08' 00"	2° 00' 42 "	Sg.Bekok	Yong Peng (Baru)
130° 08' 00"	2° 18' 30"	Sg. Bekok	Bekok
102° 34' 55"	2° 19' 48"	Sg. Belembang	Gunung Ladang
103° 18' 00"	1° 49' 40"	Sg. Benut	Simpang Renggam
103° 03' 42"	2° 22' 48"	Sg. Gatom	Labis (Lama)
104° 03' 42"	1° 53' 24"	Sg. Gembot	Teluk Mahkota/Kuala Sedili
102° 39' 42"	1° 53' 24"	Sg. Jementah	Jementah
103° 52' 24'	1° 44' 42"	Sg. Johor	Lembaga Kemudahan Awam Singapura
103° 03' 18"	2° 27' 28"	Sg. Juaseh	Air Panas
102° 56' 30"	2° 31' 06"	Sg. Juaseh	Kemelah
102° 30' 24"	2° 31' 06"	sg. Kesang	Kesang
103° 00' 05"	1° 45' 45"	Sg. Koris	Koris(Batu Pahat)
102° 59' 12"	2° 20' 00"	Sg. Labis	Labis(Baru)
103° 01' 48"	2° 23' 30"	Sg. Labis	Labis(Baru)
103° 40' 18"	2° 35' 12"	Sg. Labong	Endau
103° 55' 18"	1° 31' 18"	Sg. Layang-Layang	Johor Baru(Proposed Scheme)
103° 03' 00"	2° 14' 48"	Sg. Lenek	Chaah
103° 19' 20"	2° 01' 20"	Sg.Mengkibol	Kluang
103° 51' 42"	2° 16' 30"	Sg.Mersing	Jemaluang
102° 47' 15"	2° 18' 30"	Sg.Muar	Bukit Serambang
102° 48' 50"	2° 14' 40"	Sg.Muar	Lenga(Muar)
102° 49' 48"	2° 21' 12"	Sg.Muar/Sg Tui	Bukit Kepong
103° 12' 48'	2° 10' 54"	Sg.Paloh	Paloh
103° 50' 00"	1° 49' 48"	Sg.Pelepah Kanan	Kota Tinggi
104° 08' 30"	1° 22' 00"	Sg.Pengerang	Pengerang (Lama)
103° 27' 20"	1° 43' 18"	Sg.Pontian	Bukit Batu
103° 24' 58"	1° 33' 57"	Sg.Pontian Besar	Pontian
103° 24' 58"	1° 34' 35"	Sg.Pontian Besar	Bukit Batu
104° 12' 15"	1° 23' 35"	Sg.Rengit	Pengerang(Baru)
103° 24' 15"	1° 53' 25"	Sg.Sayong	Renggam
130° 29' 00"	1° 49' 00"	Sg.Sayong	Layang-Layang
102° 49' 10"	2° 30' 30"	Sg.Segamat	Segamat
102° 49' 48"	2° 31' 06"	Sg.Segamat	Segamat (Baru)

103° 58' 15"	1° 43' 00"	Sg.Selayut	Air Tawar
103° 42' 59"	1° 44' 15"	Sg.Semanggor	Komplek Kulai
103° 06' 24"	1° 52' 18"	Sg.Semberong	Parit Raja
103° 22' 00"	2° 03' 55"	Sg.Semberong	Kluang Baru
103° 56' 48"	1° 31' 18"	Sg.Serai	Kong-Kong
102° 55' 40"	1° 59' 00"	Sg.Simpang Kiri	Parit Sulong
102° 44' 18"	2° 10' 40"	(i) Sg.Pagoh	Muar(Panchor)
		(ii)Sg. Muar	-
103° 44' 24"	1° 33' 00"	Sg.Tebrau	Lembaga Kemudahan Air Singapura
103° 47' 48"	2° 31' 00"	Sg.Tenglu	Tenglu/Mersing
103° 34' 14"	1° 32' 30"	(i) Kolam Air Singapura (Pontian Kecil)	Lembaga Kemudahan Air Singapura
103° 38' 14"	1° 34' 05"	(ii) Takong Air Singapura (Gunung Pulai Besar	-
12° 42' 00"	2° 07' 20"	Imp Reservoir	Pengkalan Bukit(Muar)
102° 56' 35"	1° 48' 50"	Imp. Reservoir	Bukit Banang(Batu Pahat)

(2) The state of Kedah

100° 29' 12"	6° 19' 26"	Sg.Air Terjun	Bukit Wang
100° 57' 09"	5° 39' 18"	(i)Sg.Baling	Baling
100° 57' 33"	5° 40' 18"	(ii)Sg.Charok Juan	-
99° 49' 05"	6° 20' 41"	(i)Sg.Batu Asah	Langkawi
99° 46' 21"	6° 22' 13"	(ii)Sg.Saga	-
100° 25' 01"	5° 44' 21"	Sg.Batu Pahat	Merbok
100° 26' 36"	5° 45' 06"	Sg.Bujang	Tupah
100° 28' 26"	5° 37' 49"	Sg.Gurun	Gurun
100° 34' 54"	5° 11' 48"	Sg.Hill	Serdang
100° 43' 50"	5° 50' 40"	Sg.Hill	Sik
100° 39' 55"	5° 23' 48"	Sg.Karangan	Karangan
100° 41' 13"	6° 03' 28"	Sg.Krian	Selama
100° 45' 06"	5° 19' 21"	Sg.Krian	Mahang
100° 39' 12"	5° 41' 43"	Sg.Muda	Teloi Kanan
100° 44' 04"	6° 01' 01"	Sg.Muda	Lubuk Merbau
100° 25' 57"	6° 12' 20"	(i)Sg.Padang Terap	Bukit Pinang
100° 27' 23"	6° 12' 22"	(ii)JPT Canal	-

100° 28' 26"	6° 14' 20"	(i)Sg.Padang Terap	Kuala Nerang
100° 37' 09"	6° 14' 58"	(ii)Sg.Pedu	-
100° 40' 31"	5° 49' 03"	Sg.Pau	Jeniang
100° 36' 07"	5° 58' 28"	(i)Sg.Putat	Sg.Tiang
100° 36' 43"	5° 58' 18"	(ii)Sg.Rambai	-
100° 26' 42"	6° 24' 11"	Sg. Temin	-Changloon
100° 36' 58"	6° 15' 29"	Sg.Tenoi	Teroi
100° 31' 45"	5° 07' 28"	Sg.Tipis	Bandar Baru
100° 24' 26"	5° 48' 30"	Perigi	Perigi
100° 24' 55"	5° 47' 34"	Perigi	yen
100° 30' 07"	5° 34' 00"	Perigi	Pinang Tunggal
100° 43' 11"	5° 06' 18"	Perigi	Sg.Taka

(3) The State Of kelantan

102° 05' 45"	5° 55' 50"	Sg.Jegor	Kemahang
102° 11' 48"	5° 31' 35"	Sg.Kelantan	Kuala Krai
102° 09' 23"	6° 02' 18"	Sg.Kelantan	Pasir Mas
101° 09' 20"	5° 47' 20"	Sg.Kelantan	Tanah Merah
101° 53' 25"	5° 46' 40"	Sg.Polor	Air Lanas
102° 24' 50"	5° 49' 45"	Sg.Resau	Pasir Putih
102° 12' 55"	5° 45' 05"	Sg.Sat	Macang

(4) The State Of Melaka

102° 18' 10"	2° 27' 5"	Sg. Air Pandan	Hutan Perca
102° 23' 33"	2° 23' 13"	Sg. Anak Air Cabai	Kemnedore III dan IV
102° 15' 25"	2° 24' 35"	Sg. Batang Melaka	Gadek
102° 29' 50"	2° 16' 30"	Sg. Chin Chin	Chin Chin
102° 15' 47"	2° 17' 21"	Sg. Kesang	Perkampungan Felda Kemendore I dan II
102° 15' 47"	2° 17' 54"	Sg. Melaka	Bukit Sebukor
102° 18' 4"	2° 16' 26"	Kolam Air Air Keroh	Air Keroh/Bukit Bruang
102° 35' 16"	2° 24' 23"	Kolam Air Asahan	Bukit Duyong

(5) The State of Negeri Sembilan

102° 15' 22"	2° 56' 48"	Sg.Air Baning	Simpang Pertang
101° 54' 12"	2° 49' 10"	Sg.Bangkong	Mantin
102° 01' 28	2° 48'09"	Sg.Batang Benar	Pantai(Seremban)
102° 13' 24"	2° 56' 00"	Sg.Batang Melaka	Tampin
102° 03' 12"	2° 39' 23"	Sg.Beringin	Pedas
102° 37' 02"	2° 34' 34"	Sg.Gemas	Gemas
102° 21' 16"	2° 40' 10"	Sg.Jelai	Bukit Rokan
102° 16' 24"	2° 36' 36"	Sg.Johol	Johol
102° 03' 10"	2° 53' 10"	Sg.Kemin	Kuala Klawang(Jelebu)
102° 56' 47"	2° 37' 08"	Sg.Linggi	Sg.Linggi
102° 20' 28"	3° 05' 17"	Sg.Lui	Sg.Lui
102° 12' 56"	2° 40' 42"	Sg.Mengku	Kuala Pilah
102° 15' 00"	2° 44' 50"	Sg.Muar	Kuala Pilah
102° 22' 27"	2° 47' 57"	Sg.Muar/Sungai Jempul	Bahau(Baru)
102° 30' 10"	2° 42' 19"	Sg.Muar	Rompin
102° 32' 34"	2° 40' 10"	Sg.Muar	Pasir Besari
102° 11' 30"	2° 54' 56"	Sg.Pertang	Pertang
102° 23' 18"	2° 48' 38"	Sg.Serting	Bahau(Lama)
102° 08' 53"	2° 41' 52"	Sg.Sri Menanti(Sg.Buyau)	Sri Menanti
102° 07' 36"	2° 44' 30"	Sg.Terachi	Terachi

(6) The State of Pahang

103° 01' 54"	3° 16' 63"	Sg. Aur	Ibam, Kota Perdana, Muadzam Shah Paloh Hinai
102° 32' 48"	3° 16' 10"	Sg. Bera	Bera
102° 36' 37"	3° 09' 46"	Sg. Bera	Kepayang (DARA) Town 34 dan 35(Tentative Project)
101° 55' 00"	3° 29' 00"	Sg. Benus	Bentong
101° 23' 30"	4° 31' 20"	Sg. Bertam	Berinchang dan Tanah Rata
101° 24' 10"	4° 24' 35"	Sg. Bertam	Lembah Bertam
101° 51' 30"	3° 45' 24"	Sg. Bilut	Raub

101° 53' 00"	3° 41' 00"	Sg. Bilut	LKTP Lurah Bilut
101° 59' 0"	3° 44' 30"	Sg. Chalit dan Sg.Klau	Sungai Ruan
101° 48' 30"	3° 54' 40"	Sg. Cheroh	Cheroh
101° 54' 00"	3° 53' 18"	Sg. Dong	Dong
103° 26' 35"	2° 37' 15"	Sg. Endau	Seladang
102° 7' 10"	3° 15' 20"	Sg. Gapoi	Telemong/Manchis
101° 24' 20"	4° 34' 40"	Sg. Ikan	kampong Raja
101° 23' 15"	4° 25' 45"	Sg. Jasin	Lubok tamang
101° 59' 00"	4° 14' 25"	Sg. Jelai	Padang Tengku
102° 16' 00"	4° 05' 00"	Sg. Jelai	Mela
102° 39' 00"	3° 44' 45"	Sg. Jempul	LKTP Ulu Jempol
102° 31' 00"	3°31' 00"	Sg. Jengka	Kg.Awah/Sekim LKTP Sg. Nerek
102° 38' 45"	3° 47' 00"	Sg. Jerik	Ng Tiong Kiat
102° 52' 40"	2° 57' 51"	Sg. Keratong	Cempaka, Kota Bahagia, Kota ShahBandar Malati
102° 51' 27"	2° 50' 51"	Sg. Keratong	Cenderawasih, Pekoti Timor, Perantau Damai, Perwira Jaya
102° 51' 30"	3° 39' 45"	Sg. Kertam	LKTP Kg. New Zealand
102° 00' 30"	3° 33' 00"	Sg. Klau	Kg.Sertik
101° 47' 45"	4° 12' 30"	Sg. Koyan	Sg.Koyan
103° 15' 54"	3° 39' 42"	Sg. Kuantan	Kuantan
102° 35' 30"	3° 29' 00"	Sg. Lanting	Sekolah Perdagangan Chenor
102° 02' 10"	4° 10' 20"	Sg. Lipis	Kuala Lipis
101° 23' 50"	4° 26' 20"	Sg. Luchut	Habu
102° 46' 00"	3° 35' 00"	Sg. Maran	Maran/Bukit Tajau
103° 01' 08"	3° 23' 30"	Sg. Mentiga	Cini, Cini Timor
102° 16' 00"	3° 54' 18"	Sg. Pahang	Sg.Pulat Banjir
102° 21' 42"	3° 57' 30"	Sg. Pahang	Jerantut
103° 23' 00"	3° 30' 15"	Sg. Pahang	Pekan
103° 23' 30"	3° 30' 54"	Sg. Pahang	Peramu
101° 25' 20"	4° 31' 10"	(i) Sg. Palas	Tringkap
101° 25' 03"	4° 30' 02"	(ii) Sg. Tringkap	-
101° 24' 40"	4° 30' 05"	Sg. Perlong	Kuala Terla
102° 01' 30"	3° 42' 18"	Sg. Pertang	LKTP Lembah Klau

101° 55' 49"	3° 03' 20"	Sg. Riang	Sg.Ruan
101° 21' 40"	4° 24' 20"	(i) Sg. Ringlet	Ringlet
101° 23' 10"	4° 24' 45"	(ii)Sg. Telaga	-
102° 22' 18"	4° 04' 42"	Sg. Retang	LKTP Padang Piol
102° 21' 00"	3° 29' 00"	Sg. Semantan	Temerloh/Mentakab
102° 31' 48"	3° 52' 00"	Sg. Tekam	Sg.Tekam
102° 33' 42"	3° 50' 00"	Sg. Tekam	LKTP tekam/Utara
102° 02' 00"	3° 23' 00"	Sg. Telemong	Karak
102° 26' 00"	3° 50' 30"	Sg. Terpai	Bukit Nekmat(Banjir)
102° 48' 30"	3° 44' 00"	Sg. Tras	Tras
102° 18' 00"	3° 18' 00"	Sg. Triang	Bt.Mendi/Bt.Runchong
101° 24' 30"	3° 14' 30"	Sg. Triang	Triang
101° 43' 24"	3° 42' 18"	Kolam Air	Bukit Fraser
103° 29' 36"	2° 48' 24"	Perigi (Well Points) Kg. Kolam Air	Rompin

(7) The State Of Penang

100° 16' 10"	5° 24' 00"	Sg. Air Hitam	Pulau Pinang
100° 15' 56"	5° 24' 13"	Sg. Air Hitam (Sg.Tepi)	Pulau Pinang Bekalan untuk Kolam Air, Air Itam
100° 16' 58"	5° 26' 25"	Sg. Air Terjun	Pulau Pinang
100° 14' 41"	5° 26' 53"	Sg. Batu Ferringhi	Pulau Pinang
100° 14' 28"	5° 26' 51"	Sg. Batu Ferringhi	Pulau Pinang Bekalan untuk Kolam Air Guilemard dan Kolam Air Batu Ferringhi
100° 14' 20"	5° 27' 17"	Sg. Batu Ferringhi	Pulau Pinang Bekalan untuk Kolam Air Guilemard dan Kolam Air Batu Ferringhi
100° 14' 20"	5° 26' 52"	Sg. Batu Ferringhi	Pulau Pinang Bekalan untuk Kolam Air Guilemard dan Kolam Air Batu Ferringhi
100° 14' 42"	5° 26' 55"	Sg. Batu Ferringhi	Pulau Pinang Bekalan

			untuk Kolam Air Guilemard dan Kolam Air Batu Ferringhi
100° 14' 45"	5° 27' 12"	Sg. Batu Ferringhi	Pulau Pinang Bekalan untuk Kolam Air Guilemard dan Kolam Air Batu Ferringhi
100° 14' 45"	5° 27' 27"	Sg. Batu Ferringhi	Pulau Pinang Bekalan untuk Kolam Air Guilemard dan Kolam Air Batu Ferringhi
100° 17' 32"	5° 26' 04"	Highlands	Pulau Pinang
100° 17' 28"	5° 25' 02"	Highlands	Bekalan untuk Kolam air, Air Terjun
100° 16' 23"	5° 27' 39"	Sg. Kecil	Pulau Pinang
100° 16' 18"	5° 27' 44"	Sg. Kecil	Pulau Pinang Bekalan untuk Kolam Air Guilemard dan Kolam Air Batu Ferringhi
100° 16'37"	5° 27' 23"	Sg. Klean	Pulau Pinang
100° 15' 49"	5° 26' 23"	Talian Kuasa Sg. Klean	Pulau Pinang Bekalan untuk Kolam Air Guilemard dan Kolam Air Batu Ferringhi
100° 13' 33"	5° 24' 15"	Sg. Pinang Barat	Pulau Pinang
100° 13' 40"	5° 24' 16"	Sg. Pinang Barat	Bekalan untuk Kolam Air Balik Pulau
100° 14' 17"	5° 28' 15"	Anak sungai Sebelah 3Vs	Pulau Pinang
100° 16' 33"	5° 27' 41"	Sg. Siru	Pulau Pinang
100° 16' 45"	5° 24' 55"	Anak Sungai Tats	Pulau Pinang
100° 12' 13"	5° 27' 00"	Sg. Telok Awak	Pulau Pinang
100° 12' 14"	5° 26' 53"	Sg. Telok Awak	Pulau Pinang Bekalan untuk Kolam Air Guilemard dan Kolam Air Batu Ferringhi
100° 12' 15"	5° 26' 51"	Sg. Telok Awak	Pulau Pinang Bekalan untuk Kolam Air

			Guilemard dan Kolam Air
100° 12' 50"	5° 26' 56"	Sg. Telok Bahang	Pulau Pinang
100° 15' 25"	5° 27' 47"	Sg. Tengah.	Pulau Pinang
100° 13' 18"	5° 26' 37"	Sg. Ubi (anak Sg. Telok Bahang)	Pulau Pinang Bekalan untuk Kolam Air Guilemard dan Kolam Air Batu Ferringhi
100° 14' 55"	5° 25' 09"	Kolam Air Tiger Hill	Pulau Pinang Bekalan untuk kawasan penduduk Bukit Bendera
100° 15' 51"	5° 23' 46"	Empangan Air Hitam	Pualu Pinang bekalan untuk Kolam Air,Air Itam
100° 14' 13"	5° 26' 50"	Perigi	Pulau Pinang
100° 14' 23"	5° 26' 46"	Perigi	Pulau Pinang
100° 14' 35"	5° 26' 49"	Perigi	Pulau Pinang
			Seberang Perai Tengah
100° 30' 39"	5° 21' 02"	Sg. Chorak Tok/stesyen Keretapi Bukit Seraya	Seberang Perai Tengah
100° 29' 42"	5° 21' 24"	(i) Sg. Kelang Ubi	Seberang Perai Tengah
100° 30' 13"	5° 26' 05"	Sg. Kulim	Seberang Perai Utara
100° 29' 15"	5° 33' 24"	Sg. Muda	Seberang Perai Utara
100° 29' 52"	5° 22' 33"	Kolam Air Bukit Berapit/ Sg. Mengkuang	Seberang Perai Tengah
100° 30' 39"	5° 21' 02"	(ii) Kolam Air Cherok Tok Kun	Seberang Perai Tengah
100° 32' 11"	5° 09' 35"	Kolam Air Bukit Panchor	Seberang Perai Selatan

(8) The State of Perak

100° 45' 53"	4° 52' 05"	(i) Air Terjun	-
100° 46' 29"	4° 50' 39"	(ii) Sg. Batu Tugoh	Taiping
100° 44 45"	4° 48' 39"	(iii) Sg. Larut	-
100° 46' 15"	4° 52' 53"	(iv) Sg. Rantin	-
100° 16' 56"	4° 50' 14"	(v) Sg. Tupai	-
100° 31' 48"	3° 47' 52"	Sg. Behrang	Behrang
100° 03' 47"	5° 47' 21"	Sg. Bemban	Sungai Siput

100° 51' 12"	4° 54' 29"	(i) Sg. Biong	Sauk
		(ii) Sg. Perah	-
101° 00' 22"	5° 45' 08"	Sg. Chobang Annak	Kroh
100° 53' 19"	4° 45' 31"	Sg. Dal	Kuala Kangsar
100°51' 23"	4° 36' 17"	Sg. Guar	Manong
101° 00' 41"	5° 11" 43"	Sg. Ibul	Sumpitan
100° 53' 14"	5° 09' 10"	(i) Sg. Ijok	Ijok
100° 54' 14"	5° 09' 17"	(ii) Sg. Klian Gunong	-
100° 45' 12"	4° 53' 49"	Sg. Jana	Sungai Jana
101° 11' 02"	4° 28' 19"	Sg. Jelintoh	Gopeng
101° 34' 10"	3° 41' 47"	Sg. Kading	Tanjong Malim
101° 09' 41"	4° 22' 02"	Sg. Kampar	Kampar
100° 49' 33"	4° 45' 04"	Sg. Kangsar	Kuala Kangsar
		(i) Sg. Kuning	Baru
101° 07' 27"	4° 25' 33"	Sg. Kendrong	Grik
101° 09' 58"	4° 20' 17"	Sg. Kinchap	Kampar
101° 04' 19"	5° 59' 00"	Sg. Kuncha	Lintang Lasah
100° 49' 52"	4° 54' 25"	Sg. Kurau	Batu Kurau
101° 10' 39"	4° 42' 49"	(i) Sg. Kinding	Kinta
101° 12' 04"	4° 40' 06"	(ii) Sg. Kinta	-
101° 15' 48"	4° 17' 17"	Sg. Lah	Tapah dan Chendering
101° 13' 33"	5° 27' 31"	Sg. Lebey	Bersia
101° 57' 39"	5° 06' 54"	Sg. Lenggong	Lenggong
100° 47' 00"	4° 31' 19"	Sg. Lichin	Bruas
101° 10' 35"	4° 21"21"	Sg. Palai	Malim Nawar
101° 06' 00"	4°28' 40"	Sg. Perak	Ipoh
100° 54' 57"	4° 29' 17"	Sg. Perak	Greater Ipoh
100° 49' 23"	5° 14' 47"	Sg. Siputeh (Sg. Bayor)	Sungai Bayor
101° 29' 25"	3° 51' 27"	Sg. Slim	Kg. Baru Slim
101° 02' 29"	4° 37' 54"	Sg. Tapah	Sungai Tapah
101° 24' 41"	4° 00' 54"	Sg. Tesong	Sungai Klah Sungkai
109° 44' 04"	5° 13' 23"	Sg. Torak	Selama
101° 25' 29"	3° 57' 17"	Sg. Trolak	Trolak
100° 45' 25"	4° 41' 27"	Sg. Trong	Matang
101° 21' 45"	4° 12' 56"	Sg. Woh	Low Perak Baru

(9) The State of Perlis

100° 10' 05"	6° 30' 30"	Sg. Batu Pahat	Sungai Batu Pahat
100° 08' 25"	6° 26' 12"	Anak Sungai	Bukit Wei Kuala Perlis
100° 16' 30"	6° 25' 13"	Anak Sungai	terusan Utara Guar Sanji
100° 18' 10"	6° 39' 45"	Kolam Air Padang Besar	Padang Besar
100° 09' 05"	6° 26' 30"	Perigi	Wang Besar
100° 10' 10"	6° 32' 50"	Perigi	Anak Gelong
100° 11' 15"	6° 39' 45"	Perigi	Gua Hantu
100° 16' 15"	6° 25' 15"	Perigi	Arau
100° 16' 30'	6° 41' 12"	Perigi	Bukit Mata Air Padang
100° 19' 00"	6° 31' 25"	Perigi	Felda Chuping

(10) The State of Selangor

101° 48' 06"	3° 09' 42"	Sg. Ampang	Pengambilan Ampang
101° 40' 06"	3° 27' 54"	Sg. Batang Kali	Ulu selangor Selatan
101° 04' 48"	3° 43' 48"	Sg. Bernam	Kg. Tok KHalifah
101° 06' 00"	3° 44' 36"	Sg. Bernam	Bagan Terap
101° 26' 48"	3° 44' 24"	Sg. Bernam	Kampong selisek
101° 31' 06"	3° 11' 42"	Sg. Buloh	Subang
101° 35' 12"	3° 13' 42"	Sg. Buloh	Sg. Buloh
101° 33' 12"	3° 05' 00"	Sg. Damansara	Bukit Jelutong
101° 31' 42"	3° 24' 24"	Sg. Darah	Sungai Buaya
101° 23' 54"	3° 40' 30"	Sg. Dusun	Sungai Dusun
101° 41' 30"	3° 36' 42"	Sg. Gerachi	-
101° 44' 00"	3° 18' 30"	Sg. Gombak	Gombak
101° 35' 46"	3° 38' 54"	Sg. Inki	Ulu selangor Utara
101° 45' 36"	3° 14' 16"	Sg. Klang	Ampangan Klang Gates
101° 46' 42"	3° 10' 00"	Sg. Kongsi Lapan	Takungan Air Ampang
101° 37' 36"	3° 14' 18"	Sg. Kroh	Kepong
101° 40' 48"	3° 35' 12"	Sg. Kubu	Kuala Kubu Bahru
101° 40' 48"	2° 50' 48"	Sg. Langat	Bukit Tampoi(Baru)
101° 40' 48"	2° 50' 48"	Sg. Langat	Bukit Tampoi (Lama)
101° 46' 36"	3° 02' 36"	Sg. Langat	Cheras

101° 47' 18"	3° 04' 42"	Sg. Langat	Sg. Langat
101° 38' 06"	2° 57' 36"	Sg. Rasau	Pulau Meranti
101° 44' 18"	3° 17' 54"	Sg. Rumput	Sg. Rumput
101° 26' 48"	3° 24' 00"	Sg. Selangor	Rantau Panjang (Lama)
101° 26' 48"	3° 24' 00"	Sg. Selangor	Rantau Panjang Loji Pengolahan (Baru)
101° 27' 48"	3° 20' 18"	Sg. Sembah	Batu Arang
101° 28' 48"	3° 05' 48"	Sg. Serai	Lembah Ulu Langat
101° 28' 48"	3° 10' 00"	Sg. Subang	Hummock Utara
101° 25' 30"	3° 37' 30"	Sg. Tengi	Sg. Tengi

(11) The State of Terengganu

102° 29' 25"	5° 34' 30"	Sg. Bekok	Tenang (FELDA)
102° 29' 0"	5° 44' 12"	Sg. Besut	Jerteh
102° 50' 10"	5° 26' 15"	Sg. Chalok	Chalok(Felda)
103° 20' 18"	4° 41' 30"	Sg. Dungun	Bandar Dungun
103° 16' 10"	4° 15' 50"	Sg. Kemaman	Seberang Tayor
103° 19' 30"	4° 13' 05"	Sg. Kemaman	Sungai Pinang
103° 19' 18"	4° 32' 26"	Sg. Kerteh	Rasau Kerteh (Sementara)
102° 59' 00"	5° 18' 12"	Sg. Nerus	Belara (FELDA)
102° 44' 38"	5° 31' 10"	Sg. Setiu	Kampong Penarik
103° 10' 18"	4° 56' 00"	Sg. Telemboh	Jerangau
103° 00' 35"	5° 05' 55"	Sg. Terengganu	Kuala Brang
103° 02' 40"	5° 13' 05"	Sg. Terengganu	Pulau Babi
103° 05' 45"	5° 18' 48"	Sg. Terengganu	Pulau Musang
103° 24' 30"	4° 25' 00"	Sg. Tumpat	Kemasik

(12) The State of Sarawak

112° 50' 05"	1° 02' 26"	Batang Ai	Lubuk Antu
114° 19' 29"	4° 10' 40"	Batang Baram	Marudi
114° 24' 43"	3° 45' 56"	Batang Baram	Long Lama
111° 32' 10"	2° 40' 19"	Batang Jemoreng	SMK Matu/ Daro
112⁰ 08' 11"	2° 23' 55"	Batang Oya	Nanga Sekuau

112° 9' 34"	2° 05' 07"	Batang Rajang	SMK kanowit
112° 56' 37"	2° 01' 08"	Batang Rajang	Kapit
111° 37' 10"	1° 17' 08"	Batang Sekerang	Sekerang
111° 31' 00"	1° 08' 14"	Batang Undup	Simanggang
111° 40' 15"	1° 17' 08"	Sg. Bakong	SMK Bintang/RTTC
114° 58' 48"	1° 08' 14"	Sg. Berawan	Limbang
111° 41' 11"	2°04' 15"	Sg. Binatang	Binatang
111° 25' 00"	4° 06' 15"	Sg. Dor	Melugu
115° 00' 16"	4° 41' 34"	Sg. Emoak	Pandaruan
111° 32' 16"	1° 24' 31"	Sg. Entanak	Betong
115° 23' 11"	4° 49' 34"	Sg. Gaya	Lawas
111° 54' 15"	2° 01' 41"	Sg. Julau	Julau
112° 09' 05"	2° 05' 57"	Sg. Kanowit	Kanowit
112° 33' 06"	2° 00' 10"	Sg. Katibas	Song
110° 30' 21"	1° 5' 53"	Sg. Kayan	Tebakang
113° 55' 44"	4° 06' 26"	Sg. Kejapil	Bekenu
114° 02' 06"	4° 18' 18"	Sg. Liku	Miri
110° 47' 06"	1° 22' 03"	Sg. Malanjok	Simunjan
111° 37' 30"	2° 03' 42"	Sg. Maradong	Maradong
111° 38' 13"	1° 07' 53"	Sg. Marup	Engkili
113° 45' 03"	3° 48' 00"	Sg. Niah	SMK Subis
111° 27' 41"	2° 01' 18"	Sg. Paoh	SMK Sarikei
112° 03' 47"	2° 18' 14"	Sg. Pasai	SMK Sibu Pedalaman
112° 04' 19"	2° 52' 26"	Sg. Petanek	Mukah
110° 34' 45"	1° 08' 29"	Sg. Ranchan	Serian
110° 19' 03"	1° 43' 44"	Sg. Sabun	Santubong
111° 30' 05"	2° 01' 34"	Sg. Sarikei	Sarikei
109° 47' 44"	1° 47' 41"	Sg. Sebat Besar	Sematan
109° 50' 32"	1° 41' 13"	Sg. Sebemban	Lundu
111° 19' 34"	1° 47' 15"	Sg. Sebetan	Saratok
111° 17' 52"	1° 53' 07"	Sg. Seblak	Roban
110° 07' 53"	1° 24' 16"	Sg. Seburan	SMK Tasek Bau
112° 05' 49"	2° 19' 54"	Sg. Sibintek	Sibintek
113° 05' 59"	3° 11' 57"	Sg. Sibiu	Bintulu
110° 11' 56"	1° 26' 52"	Sg. Siniawan	Siniawan
110° 37' 08"	1° 08' 03"	Sg. Sinyaru	Triboh
112° 32' 24"	2° 56' 17"	Sg. Suyong	Balingian

111° 24' 04"	1° 17' 28"	Sg. Tapah	Tapah/Beratok
111° 57' 00"	2° 45' 07"	Sg. Ud	Dalat
111° 24' 45"	1° 33' 54"	Tadahan Paya	SMK Debak

(13) The State of Sabah

116° 20' 17"	05° 25' 15"	Sg. Baiays	Bingkor
116° 45' 00"	06° 28' 00"	Sg. Bandaru	Kota Marudu
118° 19' 48"	05° 01' 38"	Sg. Edam	Lahad Datu
118° 19' 45	04° 25' 17"	Sg. Gading-Gading	Semporna
118° 04' 45"	05° 51' 18"	Sg. Kebun China	Sandakan
116° 33' 28"	06° 32' 00"	Sg. Kukut	Timbang Mengaris
115° 34' 43"	05° 06' 25"	Sg. Lakutan	Sipitang/Mesapol
115° 57' 24"	05° 07' 00"	Sg. Langut	Tenom
116° 09' 00"	05° 19' 18"	Sg. Liawan	keningau
116° 38' 40"	05° 57' 08"	Sg. Liwagu	Ranau
115° 37' 30"	05° 11' 55"	Sg. Lingkungan	Weston/Lingungan
118° 27' 45"	04° 25' 26"	Sg. Luran	Semporna
118° 24' 45"	04° 22' 50"	(i) Sg. Mantarilip	Semporna
118° 25' 45"	04° 23' 47"	(ii) Sg. Mantarilip	Semporna
117° 33' 04"	05° 50' 07"	Sg. Moynod	Beluran
116° 06' 35"	05° 54' 53"	(ii) Sg. Moyog (Lama)	Kota Kinabalu
116° 09' 28"	05° 55' 20"	(ii)Sg. Moyog (Baru)	-
115° 47' 50"	05° 28' 15"	Sg. Membakut	Membakut
115° 46' 00"	05° ²0' 38"	Sg. Padas	Beaufort
115° 57' 23"	05° 42' 52"	Sg. Papar	Papar
116° 25' 18"	05° 02' 00"	Sg. Penawan	Nabawan
116° 34' 30"	06° 00' 30"	Sg. Romowanan	Kundasang
118o 16' 48"	05o 2' 00"	Sg. Sepagaya	Lahad datu
118° 03' 08"	05° 51' 30"	Sg. Sibuga	Sandakan
117° 53' 53"	04° 15' 25"	Sg. Tawau	Tawau (Lama)
117° 52' 50"	04° 16' 52"	Sg. Tawau	Tawau (Baru)
116° 20' 17"	05° 40' 30"	Sg. Tandular	Tambunan
116° 06' 15"	05° 37' 55"	Sg. Telupid	Telupid
116° 15' 58"	06° 08' 00"	Sg. Tuaran	Tamparuli
116° 13' 44"	06° 10' 23"	Sg. Tuaran	Tuaran

116° 48' 05"	06° 56' 20"	Kolam Air Penangsoo	Kudat
118° 14' 40"	04° 42' 05"	Matair Kunak	Kunak
115° 34' 20"	05° 30' 00"	Lubang Korek	Kuala Penyu
Di kawasan tadahan Kabun China		Lubang Korek	Sandakan (Bawah Tanah)
Kawasan lapangan Terbang Labuan		Lubang Korek	Labuan
116° 25' 50"	06° 21' 25"	Perigi	Kota Belud

FIFTH SCHEDULE

ENVIRONMENTAL QUALITY ACT 1974

ENVIRONMENTAL QUALITY (SEWAGE AND INDUSTRIAL EFFLUENTS) REGULATIONS 1978

[Regulation 8 (4)]

LIST OF PARAMETERS THE LIMITS OF WHICH TO BE SPECIFIED.

(i) Ammoniacal Nitrogen
(ii) Sulphate
(iii) Chloride
(iv) Cobalt
(v) Colour
(vi) Detergents, Anionic
(vii) Fluoride (as F)
(viii) Molybdenum
(ix) Nitrate Nitrogen
(x) Phosphate (as P)
(xi) Polychlorinated Biphenyls
(xii) Selenium
(xiii) Silver
(xiv) Beryllium
(xv) Vanadium
(xvi) Radioactive Material

(xvii) Pesticides, fungicides, herbicides, insecticides, rodenticides, fumigants or any other biocides or any other chlorinated hydrocarbons

(xviii) A substance that either by itself or in combination or by reaction with other waste or refuse may give to any gas, fume or odour or substance which causes or likely to cause pollution.

SIXTH SCHEDULE

ENVIRONMENTAL QUALITY ACT 1974

ENVIRONMENTAL QUALITY (SEWAGE AND INDUSTRIAL EFFLUENTS) REGULATIONS 1978

[Regulation 11 (5) (*b*)]

PARAMETER LIMITS OF EFFLUENT OTHER THAN OF STANDARD A OR B

Parameter	*Units*	*Limit*
(i) Temperature	^{o}c	45
(ii) pH Value	-	5.0-9.0
(iii) BOD_5 at 20^{o}c	mg/1	400
(iv) COD	mg/1	1000
(v) Suspended Solids	mg/1	400
(vi) Mercury	mg/1	0.10
(vii) Cadmium	mg/1	1.0
(viii) Chromium, Hexavalant	mg/1	2.0
(ix) Arsenic	mg/1	2.0
(x) Cyanide	mg/1	2.0
(xi) Lead	mg/1	2.0
(xii) Chromium, Trivalent	mg/1	10
(xiii) Copper	mg/1	10
(xiv) Manganese	mg/1	10
(xv) Nickel	mg/1	10
(xvi) Tin	mg/1	10
(xvii) Zinc	mg/1	10
(xviii) Iron (Fe)	mg/1	50

(xix) Phenol	mg/1	5.0
(xx) Sulphide	mg/1	2.0
(xxi) Oil and Grease	mg/1	100

SEVENTH SCHEDULE

ENVIRONMENTAL QUALITY ACT 1974

ENVIRONMENTAL QUALITY (SEWAGE AND INDUSTRIAL EFFLUENTS) REGULATIONS 1978

[Regulation 22 (1)]

METHOD OF COMPUTING EFFLUENT-RELATED LICENCE FEE

1. The amount of effluent-related licence fee shall be subject to-

(1) the total amount of organic loading determined as the total biochemical oxygen demand (BOD_5 at 20°C) of the effluent expressed in metric ton (tonne)

(2) the total amount of toxicity determined as the total amount of contaminants, listed as parameters (vi) to (xvi) in the Third Schedule and parameters (xi) to (xviii) listed in Fifth Schedule, present in the effluent expressed in kilogrammes (kg); and

(3) the total amount of other toxicity determined as the total amount of contaminants, listed as parameters (xvii) to (xxiii) in Third Schedule and any other parameters the Director-General thinks fit present in the effluent expressed in kilogrammes (kg).

2. The licence fee shall be computed in accordance with paragraph 1 of this schedule as follows:

		FEE	
Inland Waters into which effluent is discharged	*per tonne of BOD load specified in sub-paragraph 1 (1)*	*per kg of contaminants specified in sub-paragraph 1 (2)*	*per kg of contaminants specified in sub-paragraph 1 (3)*
(a) Inland waters specified	$100.00	$500.00	$100.00

in regulation 8 (1) (*a*)			
(b) any other inland waters	$10.00	$50.00	$10.00

LIST OF AMENDMENTS

Amending Law	*Short title*	*In force from*
P.U.(A) 400/97	Environmental Quality (Sewage and Industrial Effluents) (Amendment) Regulations 1997	17-10-1997
P.U.(A) 398/2000	Environmental Quality (Sewage and Industrial Effluents) (Amendment) Regulations 2000	31-10-2000

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